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VIEW FROM DINGMAN'S FERRY, LOOKING UP THE DELAWARE RIVER.

FIRST ANNUAL REPORT

OF THE

GEOLOGICAL SURVEY

OF THE

STATE OF NEW JERSEY,

FOR THE YEAR 1854.

NEW BRUNSWICK:
PRINTED AT THE FREDONIAN OFFICE.
1855.

SUPERINTENDENT'S REPORT.

To his Excellency, Rodman M. Price, Governor of the State of New Jersey:

SIR:—Having been honored by you, with the charge of superintending the geological survey of this State, I beg leave herewith to submit the following reports, for the consideration of the Legislature, of the progress of the survey for the past year.

These reports embrace, generally, an account of the plan which has been adopted in prosecuting the work, and some of the results which have an important economical application to agriculture, mining, &c., it being deemed advisable, at this early period, to abstain from any details or theoretical considerations, leaving them to their more appropriate place in the final minute and systematic report.

GENERAL REMARKS.

The object of the survey is to lay before the people of this State as much practical and available information as possible, respecting its natural resources and advantages.

The investigations necessary to the accomplishment of this object, are embraced under the following heads:

1. To determine the different varieties of rocks, and their relative position.

2. Their thickness and geographical range.
3. Their mineral and palæontological contents.
4. Their lithological and chemical character.
5. Their application to agriculture, mining, architecture, &c.
6. Their topographical features.

The discovery of valuable mineral substances; the establishment of principles which will serve as unerring guides to their discovery and extent; and the utter uselessness of searching for them, except in particular geological formations; the derivation, composition and character of soils; their means of improvement and adaptation to particular plants; the plotting and construction of public works, such as railroads, canals, &c.; architecture; great internal improvements; determining the availability of water courses; establishing the most economical plans for drainage—thus rendering unhealthy districts, healthy and unproductive lands fertile; mining; and almost every branch of the arts and manufactures are included in the above investigations.

In order to arrive at the most reliable and thorough results, demanded by such investigations, researches in the following departments of practical science are required:

Topographical Engineering.
Geology.
Palæontology.
Chemistry and Mineralogy.

TOPOGRAPHICAL ENGINEERING.

Topographical and Geographical Maps—Sections.

The topographical or physical features of a country depend on its geological formations. Wherever there is a change in the underlying rocks, there is a corresponding change on the surface, indicating the extent and limits of each formation, and serving as guides to the explorer. The varied aspect of a country, its mountain scenery, hills and dales, plains, water-

falls and courses, all depend, to a greater or less extent, on the change from one formation of rock to another. In making a geological examination of a country, one of the first objects to be accomplished is to represent, on a topographical map, the precise locations and boundaries of the different formations of rocks; also to draw vertical and horizontal sections and profiles of the surface configurations, which will show the order of superposition of the strata and layers of rocks, and their thickness. Hence the importance, in all minute and detailed geological investigations, of an accurate representation of the topographical features of a country. Without this it is totally impossible to describe its orographical structure.

It is to be regretted that, of the many geological surveys of the different States of the Union, none have been preceded by an accurate topographical map. England, France, and some countries of the Continent, understanding its importance, have conducted their geological surveys on a proper basis, and thus furnished to the world that minuteness and accuracy of geological representation and description nowhere to be found in this country.

GEOLOGY.

The term rock, in geological language, not only applies to the hard, solid portion of the earth's crust, but also to the soft and loose materials, such as beds of sand, clay, peat, marl, and soil. They do not occur in a confused and irregular manner, but have a systematic order of arrangement, by which they may be classified into groups depending on their origin, relative age, and general characters.

The most general classification is that which refers to their origin, and which divides them into three principal classes—igneous, aqueous, and metamorphic.

Igneous Rocks.—The igneous rocks are those which have been formed by the action of heat in the central portion of the earth, and ejected to the surface in a molten state. On cooling, they assume a crystalline aspect, and are generally com-

posėd of one or more of the following simple minerals:—feldspar, quartz, hornblende, and mica. They occur in veins, dikes, great irregular masses traversed by joints and divisional planes, constituting mountains, ridges, &c.

AQUEOUS ROCKS.—The aqueous rocks are those which have been formed by the agency of water, from the disintegrated particles of other rocks transported by currents, and deposited as sediment, in the form of strata, beds, layers, laminæ, &c. They very often contain organic remains of plants and animals.

METAMORPHIC ROCKS.—The metamorphic rocks are those which have been formed by aqueous agencies, and subsequently so much altered in their texture by the action of heat, as to resemble igneous rocks. They contain no visible organic remains.

The above is a very general classification of rocks, derived from their origin. They are subdivided into groups called systems, according to their relative age. It is to be regretted that much confusion prevails in regard to their nomenclature.

Every country, and almost every geologist, has a particular system of names, derived either from characteristic fossils, localities, or some lithological peculiarity of the rocks. Those most generally used and understood in this country, are the nomenclature of the English geologists, and that proposed by the geologists of the New York survey. The former is chiefly derived from localities in Great Britain, the latter from localities in New York where particular groups of rocks are well developed. As this was the first attempt at a complete classification of the rocks of this country, it has been generally adopted in different States of the Union, and undoubtedly will remain as a standard of comparison. Geological investigation arranges and classifies the rocks, represents their extent, thickness, and order of arrangement, by means of sections, profiles, &c.; points out and describes the valuable mineral deposits of each formation, and the manner in which they may be worked and applied to various economical purposes. But in order to

accomplish this most successfully, it must call to its aid palæontology, mineralogy, and chemistry.

It is by means of the minerals, and organic remains, that the geologist is enabled to determine the varieties of rocks, and their relative ages—one of the most important considerations in a practical or economical view, for it is only in particular formations, and of a particular relative age, that valuable mineral deposits occur. For example, in connection with the igneous and metamorphic rocks (azöic), as granite, trap, gneiss, chloritic, talcose, and hornblende slates, beds of quartz and saccharoidal marbles, or white crystalline limestone, occur the principal metalliferous deposits, as gold, silver, copper, iron, zinc, &c. It is in connection with the aqueous rocks of a certain relative age, that occur the great coal deposits, &c. The former are determined by their lithological character, the latter by their organic remains.

PALÆONTOLOGY.

(ORGANIC REMAINS OF ANIMALS AND PLANTS.)

Its Importance and Relation to Geology.

Palæontology is the science which treats of fossil remains. It has been satisfactorily proved by geological and palæontological research, that at different periods of time the crust of the earth has undergone numerous and various changes; that at one time it was inhabited by no living being; that the waters of the ocean covered its surface; that at a certain period animals and plants sprang into existence, and after living through a few generations died, leaving their remains entombed in the sedimentary deposits of the ocean's bed. Starting from this point, as we ascend in the scale of animal and vegetable existence, we find new tribes of animals and plants successively appearing and disappearing, generation ssucceeding generations, until finally man and his associates, the most perfect of them all, crown the era of animal existence. Some tribes and species have lived through long and successive peri-

ods of thousands of years, others for comparatively but a short period. It is often asked during what length of time have all of these successive changes taken place. But the geologist can compute time only by comparison. That it must have been inconceivably great, no one who studies the vast sedimentary deposits in which these remains are found before man appears upon the surface, and then compares the time which was necessarily required in forming these deposits with the time during which that portion of the earth's crust was deposited in which the remains and works of man are found, will fail to conclude that it is impossible to form an adequate idea of its long duration.

Having perfected and regulated the order of succession in which these changes have taken place, the geologist, commencing with the oldest aqueous rocks, reads the condition of the earth at that period, the state of the atmosphere and its temperature, the changes which took place by aqueous and volcanic agencies, and then, coming as it were to a chapter of more modern history, he reads of another period; and thus, turning page after page, examines successively the changes which have marked the earth's history during a lapse of millions of years.

So regularly have these changes occurred over the whole surface of the earth, that the nature of the organic remains is sufficient to determine the general character of the rocks, and the period at which they were formed.

Perhaps it may not be out of place here to remark, for the information of many with whom I have conversed in different parts of the State during the past year, and who entertained an idea that the principal object in collecting fossils, or organic remains, was merely the formation of cabinets of curiosities at the State capitol, and at the various county seats, at a large expenditure of the public money, that the organic remains found in the rocks constitute the basis of economical geology. It is to them that many of the valuable discoveries in the aqueous rocks are due. The researches of Messrs. Conrad and Hall, have been the means of placing the geology of this country on

its proper basis. Had it not been for the fossils, or remains of plants and animals that were found in the aqueous rocks of the State of New York, the geologists of the survey of that State would not have been able to determine the non-existence of coal in that region, which has been the means of preventing a useless expenditure of thousands of dollars, in searching for that material. It was by means of organic remains that the extent and boundaries of the salt-bearing rocks of that State have been ascertained and accurately defined. It is by means of the occurrence of particular fossils in the marl formations of this State, that the researches of the past year have proved the existence of three distinct beds, and determined accurately the extent and thickness of each of them—a matter of great importance to the land-holders of that section of the State. It is evident, then, that to attempt to describe the geological features of a country, and particularly their economical importance, without considering their organic remains, would be throwing aside the grand principles upon which the science is founded.

CHEMISTRY AND MINERALOGY.

In the preceding paragraphs we have referred to the different formations of rocks which compose the crust of the earth, and the various changes which from time to time they have undergone, as well as the great lapse of years during which these changes have taken place. It is one of the first principles of Natural Philosophy that no change can take place in nature, which cannot be referred to some cause, some active force, as the agency. This fact is satisfactorily demonstrated on every hand in the world around us. Whether we consider those mighty and wonderful changes in the earth, or the more insignificant changes which take place in the merest atom upon its surface, every where the same law holds good.

At this stage, then, of geological investigation, after having examined the varied results of a series of changes that have been going on for myriads of years, it becomes us to ex-

amine into the causes of these changes, and *chemistry* reveals to us the laws by which they are governed. It has been said by Bischof,* the celebrated chemical geologist, that our earth, as far as we know it, is a great chemical laboratory, in which since the period of its creation uninterrupted chemical processes have been in operation, and will continue so long as it describes its course around the sun. The soil, the atmosphere, animals, and plants, are constantly undergoing changes; and each performs its part in the great and uninterrupted circle of transmutations.

Rocks are composed of one or more distinct substances called simple minerals, such as quartz (silica), feldspar, mica, hornblende, carbonate of lime, talc, oxide of iron, &c. These simple minerals are composed of elementary substances, such as oxygen, hydrogen, carbon, silicium, aluminum, potassium, sodium, calcium, &c., which uniting together in twos form binary compounds; and it is in this latter state that they occur in minerals.

The most common binary compounds are silica, composed of oxygen and silicium; alumina, of oxygen and aluminum; lime, of oxygen and calcium; potash, of oxygen and potassium, &c.

Rocks are sometimes classified according to the predominance of some one of the above binary compounds—as a silicious or arenaceous rock, one in which quartz predominates; an argillaceous rock, one in which alumina or clay predominates; a calcareous rock, one of which lime is the principal constituent; and a carbonaceous rock, one in which carbon prevails.

Almost all the changes that take place in the rocks and materials, organic or inorganic, which constitute the crust of the earth, or grow upon its surface, have their origin in the transformations of the simple elementary bodies. Having a knowledge of the laws by which these transformations are governed, we are able to apply them to the various useful purposes of life.

* Bischof's Geologie—(Introduction.)

It is in consequence of such transformations that soils are formed of the *debris* of rocks, from which plants receive their sustenance; consequently the chemical character of soils partakes more or less of that of the rocks from which they are derived. There are other causes too, which tend to modify the composition of soils in particular localities, as the occurrence of drift, disintegration of bowlders, presence of organic matter, &c. When all of these circumstances are taken into consideration, the general properties of soils are known without subjecting them to minute chemical examinations. The decomposition and disintegration of rocks by chemical agencies is a subject of great importance in rural economy, and one which should receive careful investigation. It has an important practical application in a variety of ways. It teaches the distinctive properties of the soil, to what kind of vegetation it is adapted, and how it may be improved either by cultivation, or by the addition of foreign substances as fertilizers. It is by investigating the laws of nature in her varied chemical and mechanical changes, that we are enabled to imitate them in the practical pursuits of life, and make them subservient to our happiness and prosperity.

RESULTS OF SCIENTIFIC INVESTIGATION IN THE STATE AT THE COMMENCEMENT OF THE SURVEY.

Upon receiving my commission as superintendent of the survey, I proceeded immediately to ascertain what reliable information respecting the topography and geology of the State previous researches had already laid before the people. My principal object was to ascertain if there existed any correct maps, or reliable surveys, which might serve as a proper basis for delineating accurately the geological features of the State. The different editions of the State map, the county maps, and several local surveys were examined. None of them were found to be sufficiently correct, or to furnish the necessary data from which such a map could be compiled as

the objects of the survey, in compliance with the law, demand. Some of the results of my researches were as follows:

The first complete map of the State was compiled by Thomas Gordon, from various local surveys, together with some original surveys procured by an act of the Legislature, passed November twenty-eighth, eighteen hundred and twenty-two, authorizing a loan to Thomas Gordon of one thousand dollars, to enable him to obtain additional surveys for the purpose of making a State map. This map, known as Gordon's map, was completed and published in the year eighteen hundred and twenty-eight. During the same year, upon the sixth of March, a resolution was passed by the Legislature, authorizing the Governor to subscribe for one hundred and twenty-five copies. On the fourteenth of February, eighteen hundred and thirty-one, the Legislature passed an act authorizing the treasurer to cancel Gordon's bond, and the Governor to take one hundred and twenty-five additional copies at one thousand dollars.

A second edition of the State map was revised, corrected, and improved, by Robert E. Horner, by a resolution of the Legislature, appropriating one thousand dollars, passed February twenty-fifth, eighteen hundred and forty-seven. This is the last and most reliable edition of the State map. Every other map, made since the publication of this edition, has been compiled therefrom; and the manner in which this was made was sufficient to satisfy me of its want of accuracy, and of its insufficiency as a basis for the geological purposes of the survey. Subsequent examinations and field researches have verified my suppositions, as will be seen by referring to the annexed report of Mr. Viele, the State Topographical engineer.

In the year eighteen hundred and thirty-five, the Legislature passed an act authorizing a geological and mineralogical survey of the State, with an appropriation of one thousand dollars. This survey was conducted under the superintendence of Professor Henry D. Rogers, and the first report of it was made during the following year. March tenth, of the same

year, a further appropriation of two thousand dollars was made. March seventeenth, eighteen hundred and thirty-seven, two thousand dollars more were appropriated; and on the twenty-seventh of February, eighteen hundred and thirty-eight, two thousand copies of a final report were ordered to be published at eighty-seven cents each. This report, containing three hundred and one pages, together with a geological map, was published in eighteen hundred and forty, and embraces a general outline of the geological formations of the State, with analyses of some of the rocks, greensand, and fresh water marls and calcareous tufas, also some general observations on their application to agriculture and the arts.

The survey of Professor Rogers was as minute and detailed as the circumstances and the early day of geological science would allow; and when we take into consideration the meagre means placed at his disposal, and the short space of time allotted for the accomplishment of the work, we can do no less than say, that the outlines of the different formations were accurately defined, and a vast amount of useful information respecting the natural resources of the State presented, resulting in great public benefit, and had the people more generally availed themselves of it, would have been of still greater benefit to them in their agricultural, architectural, and many other pursuits of life.

Previous to the survey of Professor Rogers, local examinations to some extent had been made chiefly in the mineral regions of the northern part of the State, and in the marls of the southern section. Among those who took the most active part in the researches at that time, were Dr. Samuel Fowler, of Franklin, Sussex County, who published several articles in Silliman's Journal, on the mineralogy and geology of Sussex County; Prof. Nutall, Messrs. Vanuxem, Keating, and others, who, from time to time, contributed papers to Silliman's Journal, and the Journal of the Academy of Natural Sciences, of Philadelphia. Dr. Morton and Mr. T. A. Conrad, of Philadelphia, had very thoroughly examined and described the fossils of the southern section of the State. The published results of

these labors are among the most valuable contributions to science that this country has afforded, and will stand as monuments to the high scientific attainments and indefatigable industry of their authors.

During the past three or four years, many detailed local examinations have been made in the mineral regions of the State by eminent scientific men, which have resulted in very valuable discoveries of new minerals and natural fertilizers. But as the investigations have been made solely for the advancement of private interests, the people at large have been but little benefited thereby, and indeed have frequently parted with valuable property in mineral districts for a trifling consideration; things which would not have occurred had they been possessed of such reliable information as a detailed geological survey would have afforded.

At the time of the last geological survey, very little attention was paid to the importance of the application of chemical and geological researches to agriculture. The State was comparatively thinly settled, and the average quantity of rich virgin lands being very great in proportion to the inhabitants, its necessity and value were not so apparent as at the present time, when a constant tide of immigration is densely populating its territory, and the once rich lands are becoming impoverished by an exhausting system of tillage.

MINERAL RODS, HAZEL WITCHES, FOOL'S GOLD, SEARCHING FOR GOLD.

The frequent applications that have been made to me for the loan of divining or mineral rods, either for the purpose of discovering the hidden treasures that lie concealed beneath the surface of the earth, or for reaching some vein of gold, silver, or copper, of which a traditionary account has been handed down from generation to generation, or for exploring the spot where a flash of light has been seen, or an explosion heard—which by many are believed to be infallible signs of the oc-

currence of minerals; and the experiments which I have witnessed of the use of the hazel witch, for the purpose of locating wells where the water runs nearest to the surface, suggest the propriety of making some remarks by way of caution to those who believe in the efficacy of such means.

In my travels through the State, hardly a day passes on which such applications are not made to me, together with the recital of wonderful discoveries which have been made through such instrumentalities. It is not indeed wonderful, that there is so much credulity among the great masses of the people, for they have but little knowledge of the properties of minerals, or of the elementary principles of natural science. It seems to them as reasonable to believe that the presence of gold, silver or copper may be indicated by some such instrumentality, as that a vein of magnetic iron ore may be discovered by means of the magnetic needle. In order that I may give a clearer idea of the manner in which many people of this State have been duped, I will briefly mention a few cases that have come under my own observation.

Two years ago, a very worthy and respectable man called upon me, stating that he supposed I had a mineral rod that would discover a vein of copper, its depth from the surface, its width, and the quality of the ore, and that he would like to borrow it for the purpose of finding a vein of copper in Morris County, which his grandfather had discovered some sixty years ago, and some of the ore from which he had smelted in a blacksmith's forge in the vicinity. He stated that his grandfather had moved to Missouri when his father was a boy, and had often told his son of this copper vein, giving to him before his death a map of the property, upon which was indicated the precise spot where the opening had been made into it. He felt so confident that by means of this map he could go directly to the concealed treasure, that he endeavored to purchase the property at a very high price. On arriving at the premises in question, he was unable to find the opening into the vein, on account of the changes which cultivation had wrought upon the fields. He immediately applied to a man

in the vicinity who possessed a mineral rod of marvellous virtue, and who professed to be skilled in its use; told him his story, and, after receiving from the *mineralizer* assurances of the occurrence of a copper vein in that field which his mineral rod had discovered several years previous, offered to disclose it to him, together with its precise width, richness, &c., for the sum of twenty-five dollars. The stipulated amount having been paid, they proceeded to the field; the mineral rod pointed out the vein, the dimensions of which were duly defined with stakes. So well satisfied was he with the correctness of the revelations of the magic rod, that on the following day he offered to purchase the property at ten times its value. Its owner, however, catching the enthusiasm and dreaming of becoming suddenly rich, would not dispose of his property under any circumstances; but offered to lease it on very favorable terms. A lease was accordingly drawn, and our hero commenced operations by sinking a shaft over the supposed vein; and when he applied to me had already sunk the shaft twice the depth required by the revelation; and having expended several hundred dollars, was about returning to the West either to induce his father, an old, feeble man, to come and point out the spot, or to recruit himself with funds to prosecute the work.

During the last summer, I met with one of these philosophers in whose hands the divining rod possesses such wonderful powers, and who has acquired great reputation in the northern part of the State, not only from the pretended discoveries that he has made, but for his untiring efforts to unfold *hidden treasures*. After much difficulty, my curiosity was gratified by seeing the veritable rod with which, according to his own statement, he had located the principal gold mines of Virginia and North Carolina, had discovered sunken steamboats on the great lakes, had told how much silver there was in the Sussex Bank, had traced the franklinite and zinc ores of Stirling Hill for miles from their present location, had discovered the principal iron veins of New Jersey, and for which he had been offered two hundred thousand dollars by a company in California.

The instrument resembled an ordinary metallic syringe, about one inch in diameter, and five or six inches in length, having screws attached to the larger extremity, by which it could be fastened to the handle of a cane. He stated that it was made of silver, and that its virtue depended on a peculiar substance which he had discovered, and which he placed in the syringe, when he wished to search for silver ore. These instruments were made of different materials according to the metal sought; for example, if the object of his search was gold, he used one made of that metal, and charged in the same manner: if he sought iron, his instrument was of iron, &c. When on his exploring expeditions, he carried with him a number of them. He never allowed them to go out of his hands, as their magic influence would thus be at once destroyed. I was very much amused by his company during a short trip over the Sparta Mountain, when he promised to point out to me the precise locality of the franklinite and zinc veins crossing this region. He informed me, in different places, as to the precise number of feet and inches at which these veins lay from the surface; and after showing several small bowlders of zinc and franklinite ore lying on the surface of his vein, he observed: "a good many scientific geologists have been around here, who think they know every thing about minerals and so on, and they say that these are loose pieces that have travelled from the mine at Stirling Hill, but it ain't so; it's agin' nater for stones to swim or run up hill."

I would not have repeated so much of his jargon, had I not been informed that during the past three or four years he has received eight or ten thousand dollars for his professional services in that vicinity, and that a large amount of money has been expended in digging under his directions.

Water philosophers, or those who profess to be able, by means of the *witch hazel*, to discover springs and streams of water beneath the surface, are somewhat numerous throughout the State, and are often called from some distant place to decide upon locations for digging wells. I had an opportunity of witnessing the operations of one of them in locating a

stream of water, and determining its depth, capacity, &c.; but in regard to the correctness of his statements I had no visible evidence.

One of the most common delusions, and one that has caused a great expenditure of money, is the flashing of lights and rumbling noises, concerning which many notions are entertained. During the past summer, I found men on the Blue Mountain digging for gold in the hard Shawangunk grit, where lights were said to have been seen; and numerous are the excavations that have been made there in search of gold, solely on account of some traditionary tale about the appearance of fire or smoke. Among the inhabitants of that mountain there is hardly a man who has not heard of lights and rumbling noises. In several of the excavations I found iron pyrites, which, by a rapid decomposition, sometimes produces a great deal of heat and even smoke; and if lights have ever been seen, their origin can be referred to the pyrites. For the information of those who are so credulous in such matters, I may be allowed to say that they are no indication of valuable mineral deposits.

The occurrence of iron pyrites, to a greater or less extent, in almost all the rocks of the northern part of the State, has been the cause of a useless expenditure of money. On account of its resemblance to gold in color, and the frequency of its being mistaken for that mineral, it has been called "fool's gold." Many have sought me with parcels of it carefully wrapped in paper, which they had obtained at an expenditure of much labor and money, and have asked its value, together with advice as to the best method of continuing their work. It may be readily distinguished from gold by holding it in the flame of a candle or throwing it in the fire, when it will lose its brilliant hue; while gold, under the same circumstances, will preserve its color. It may also be detected by its brittleness; for if the point of a knife be pressed against it, it will break readily, while gold is tenacious and difficult to be broken.

The frequent occurrence of dark-colored slates and shales

along the Delaware River, and east of the Blue Mountain, has induced many to believe that coal must be associated with them; and many excavations have been vainly made in search of it. It often happens that coal miners, passing through the country, assert the presence of coal in these districts, on account of the similarity existing between the shales here and the slates of the coal mines in which they have worked. These men are not unfrequently employed to dig for coal. But so far as the geological researches have extended during the past year, it is ascertained that no coal exists there.

I think it may be safely said that the money expended in idle researches at the instigation of pretenders, or from a lack of information respecting the natural resources of the State, would be more than sufficient to complete the survey, and thus afford reliable information to every one of its inhabitants.

We are apt to wonder at the credulity of our forefathers in their belief in the magician's wand and the philosopher's stone, but nowhere in history have we accounts more absurd than those furnished in our very midst. In fact, there has always been a kind of superstitious feeling or credulity respecting the precious metals, and I know of no better way of dispelling it than by the promotion of education, and the dissemination of useful knowledge, in which New Jersey is now taking a very creditable stand, by the establishment of a liberal system of instruction, and by carrying on extensive internal improvements.

PLAN OF SURVEY.

The plan adopted for prosecuting the survey, and by which it has been conducted during the past year, divides it into four principal departments, viz.:

1. The Trigonometrical and Topographical.
2. The Geological.
3. The Palæontological.
4. The Chemical and Mineralogical.

TRIGONOMETRICAL AND TOPOGRAPHICAL DEPARTMENT.

On referring to the accompanying report of Mr. E. L. Viele, the State Topographical Engineer, it will be observed that this part of the survey has been vigorously prosecuted. When we take into consideration the limited means placed at his disposal for properly commencing the work, the many difficulties under which he labored at the outset, and the lateness of the season, it will be seen that much has been accomplished. It will be remembered that the object of this part of the survey is to furnish a detailed and accurate topographical map of the State, upon which its geological features may be correctly delineated, and from which sections may be made representing the thickness and superposition of each formation of rocks; and as this is the groundwork of the geological survey proper, the greater part of the funds placed at my disposal has been appropriated to its prosecution, in order that as much of the topography might be completed as possible by the opening of the next year, which being mapped out during the winter, would serve as a guide in the detailed geological examination for that year. Independent of the great importance of this survey, on account of its connection with geology, it will be of incalculable benefit in various respects. It will furnish a map upon which every mountain, hill, and valley, with their comparative dimensions, every boundary line, natural and artificial; every road, river, stream and canal; every farm and house, will be represented. By it, public works may be plotted, and systems of drainage established. It will be of great benefit in the opening of mines, quarries, and deposits of fertilizers.

GEOLOGICAL DEPARTMENT.

In the geological department two divisions of the State have been made: Northern and Southern. The line of division extends from Staten Island Sound near Elizabethport

to the Delaware River, a little below Trenton, following the southeastern border of the red shales and sandstones which stretch across the central part of the State. This line has been selected on account of its being a natural division of the State into two nearly equal parts, in respect to area, while in respect to their physical, geological and agricultural features, they are entirely different. The adoption of this division will, in the final report, be the means of avoiding unnecessary repetition.

SOUTHERN DIVISION.

The southern division of the State has been assigned to Professor George H. Cook, assistant geologist of the survey. He entered upon his duties in Monmouth County on the 27th of July last, and from that time to the present has been engaged either in the field or in the laboratory. His attention has been chiefly directed to the marl beds of the greensand formation; and a perusal of his report will satisfy all of the great importance of a more minute examination than has hitherto been made. Allow me to call your attention especially to that part of his report which refers to the following facts, proved from examinations in the field:

1. "The clays and marls which constitute the basis of most of this part of the State are in regular and continuous layers."

2. "The layers are not level, but incline or dip towards the southeast."

3. "Since those layers were formed, the action of the water, or other causes, has worn away and changed the surface of the country."

Laying aside for the present, the importance of these facts in a scientific point of view, I will merely refer to their practical application.

Although the layers of marl, constituting this formation, are not level, yet they are deposited in a certain plane whose inclination is towards the southeast. The irregularities of the

surface of the soil having been produced subsequently to the deposition of the marl layers, by the action of currents of water, winds, &c., it is evident that these irregularities are entirely independent of the surface of the marl layers. Knowing then the inclination of the layers of the latter, and adopting their surface as a base, we may, by measuring the inequalities of the surface across the formation, ascertain the precise depth of each bed of marl from the surface, and represent it by means of maps and sections; thus each landholder within the formation can determine the most accessible localities for opening marl pits. Hitherto the discovery of marl pits has been uncertain and accidental, on account of a want of that accurate information respecting their position, division into distinct layers characterized by particular fossils, and their position relative to the surface configuration. If, then, land upon which marl is accessible is worth from five to seven dollars per ten feet square upon the surface, and scientific investigation determines where such lands may be located within the five hundred and seventy-six thousand acres of this formation, it is superfluous to enlarge upon the great benefits to be derived from it.

NORTHERN DIVISION.

To the geological examination of the northern division of the State, I have given my own personal attention, and the results thereof will be seen in the sequel to this report.

PALÆONTOLOGICAL DEPARTMENT.

This being one of the most essential branches of the science of geology, I directed, at the commencement of the survey, each member of the corps to pay particular attention to searching for, gathering, and preserving organic remains. The result is, that quite a large collection of the fossils of Sussex and Monmouth counties has been made and forwarded to the State

capital, as well as to the county seats of the counties in which they are found. The collection from each formation being still incomplete, and the time very limited, it is deemed inexpedient to make any description of the specimens already procured until a subsequent report. I would recommend a vigorous prosecution of this very important department of the survey, so that upon its completion, every species of organic remains found in the State may be accurately described and represented.

CHEMICAL AND MINERALOGICAL DEPARTMENT.

Mr. Henry Wurtz, the chemist and mineralogist of the survey, entered upon his duties on the first day of November last. In order that the chemical investigations of some of the most important minerals and fertilizers might be made at as early a day as possible, I directed him to rent a building suitable for a laboratory at Trenton, and to proceed at once to furnish it with the necessary apparatus and reagents. The amount of funds set apart for this purpose being wholly insufficient, Mr. Wurtz has, by adding his own apparatus and chemicals, formed a very complete and convenient laboratory, and already made some chemical investigations of the fresh-water marls and calcareous sinters of Sussex County, the results of which will be found in his accompanying report. Prof. Cook has also been engaged in his laboratory at Rutgers College, in making examinations of the greensand marls, and the results of his researches will be found to be of very considerable importance.

CABINET.

The law authorizing the survey provides for the collection of two complete suites of specimens of all the different minerals, rocks, fossils, marls, clays, sands, peats, &c.; one to be forwarded to Trenton, to be disposed of as the Legislature may hereafter direct; the other, consisting of the minerals,

&c., peculiar to each county, to be forwarded to the county seat, and there disposed of as the Board of Freeholders shall deem proper. As far as the researches have extended in detail, three suites have been made—two for Trenton and one for the county seat. I think it advisable that two suites should be made for the State, in order that the final arrangement of the cabinet may be divided into two parts, viz.: a geological and geographical arrangement. The former to exhibit the rocks in their order, together with their associate minerals, fossils, &c., corresponding with the geological maps, sections, &c.; the latter a local arrangement in townships or sections of townships, to correspond with the accompanying local descriptions. I propose to adopt the latter alone for the county cabinets.

During the year twenty-six boxes of rocks, minerals, and fossils have been forwarded to Trenton from Sussex County, and eight to Newton. Prof. Cook has made a complete collection of the marls of Monmouth, as far as his detailed examinations have extended. They have been properly prepared and labelled, and now await a suitable place for their reception. The very great variety of minerals and organic remains of this State, will necessarily form an extensive cabinet, and I would therefore call the attention of the Legislature to the importance of taking some steps towards obtaining suitable rooms for its permanent arrangement. I would also here state that several applications have been made to me by different educational institutions in this, as well as in other States, for complete collections of New Jersey minerals, rocks, &c. But as much expense attends the collection of specimens, and as the law does not authorize more than two suites, I could not comply with any of these requests. It is very desirable, however, that a knowledge of the resources of this State should be spread as widely and rapidly as possible, and there is no more effectual way than by distributing samples of its productions to every part of the country. The subject is worthy of the consideration of the Legislature.

EXPENSES OF THE SURVEY.

Upon organizing a competent corps, consisting of an engineer, assistant geologist, chemist, and mineralogist, and other aids sufficient to commence and carry on the survey in accordance with the adopted plan, a difficulty was encountered at the outset, on account of the smallness of the appropriation.

Reconnoissances were to be made, instruments, apparatus, and chemicals to be provided and transported, and a variety of preliminary arrangements required, as may readily be expected at the opening of a work of this kind. It was evident that to commence the survey on this plan, in all the departments, not only a rigid economy must be observed, but that the greater part of the necessary instruments must be obtained otherwise than by purchase. With this view, letters were addressed to Prof. Bache, superintendent of the United States Coast Survey, laying before him the embarrassing circumstances under which we labored, and soliciting the loan of certain instruments. Prof. Bache, convinced of the great importance of the undertaking, responded unhesitatingly to our solicitations, and forwarded all that we needed; the acknowledgment of which, together with the acknowledgment of the receipt of instruments from the New Jersey Franklinite Company, will be found in the accompanying report of the topographical engineer. Each member of the corps also loaned his instruments and apparatus, and thus a great expense was avoided at the outset.

As several applications had been received from young men desirous of becoming connected with the survey, for the purpose of acquiring practical knowledge in the several departments, it was thought advisable to receive all such as volunteers, who should be willing to bear their own expenses, and have assigned to them a particular duty, to which they should attend as assiduously as if they were compensated. At different times during the year, eight have been received upon these terms; and although an acknowledgment is due to some

of them, yet, as a general rule, I do not think the plan is an economical one; for in every department of the survey, it is necessary that each member of it should know his duty, and attend to it zealously. The applicants or volunteers are chiefly young men, who have just completed their collegiate education, without any fixed business habits, and in some cases unsettled as to the choice of a profession. They enter upon the survey, and in a few weeks, becoming dissatisfied, desire to try some other department. The result is, that the party becomes disorganized, operations temporarily suspended, until a reorganization can be made; and thus, indirectly, a greater expense incurred than would compensate competent assistants. In making the above remarks, I do not wish to convey the idea that such has been the case with all the volunteers who have been engaged in the survey. Some of them have been of much service to the State, and I trust have received in return much useful and practical information. This statement I am induced to make on account of the numerous applications for such situations, as well as for the purpose of removing the impression received by many, that such services must diminish the expense of the survey.

The following is an abstract of the disbursements in prosecuting the survey for the year ending December 31, 1854:

For services,	$3,680 10	
" instruments and apparatus,	133 50	
" incidentals,	186 40	
Amount,	$4,000 00	
Appropriation for survey, made March 2d, 1854,		$4,000 00

ESTIMATE OF EXPENSES FOR THE YEAR EIGHTEEN HUNDRED AND FIFTY-FIVE.

The following is an abstract of the expenses for prosecuting the survey in an expeditious and economical manner, for the year eighteen hundred and fifty-five:

Trigonometrical and Topographical department,	$15,000
Geological Department—Southern Division,	2,000
" " Northern Division,	4,000
Chemical and Mineralogical department,	2,500
Palæontological department,	1,500
	$25,000

With this amount the topography can be extended over the greater part of the State; the geological researches made in detail as far as the topography extends, together with a general examination of the remaining portion, leaving the survey in such a condition that the entire field work of the State can be completed in eighteen hundred and fifty-six.

In the preceding pages, I have endeavored to present a general outline of the manner of prosecuting accurate geological surveys, and of the plan upon which the survey of this State has been commenced and carried on, the amount of time and means for completing it, and the benefits to be expected therefrom. I trust that the Legislature will take the matter fully into consideration, and that an ample appropriation will be made towards its rapid completion. The geographical position of the State, its varied physical aspect, geological formations, and soils, demand that every acre of its territory should be thoroughly examined. There was a time, in the infancy of the science of geology, when general investigations were deemed sufficient to answer all practical purposes. That time has passed away; economical geology has become an accurate science, and in order that the most beneficial results may be attained from its investigations, it must be pursued in an accurate manner.

SEQUEL TO NORTHERN DIVISION.

I have devoted the greater part of my time, from the middle of July to the first of December, to geological examinations of the northern division of the State. During this time I have made a reconnoissance of Sussex County, and a part of

Morris and Passaic counties; also detailed examinations of the townships of Sparta, Hardiston, Vernon, Wantage, Montague, and a part of Sandiston and Newton. Several geological sections have been made from actual measurements and levelling across the country from the Delaware River to the Highlands; also sections, on a greater scale, of important mineral localities and mines, representing the relative position, thickness and dip of each kind of rocks, and their associated ores. Twenty sketches, illustrating the physical features of the surface, and geological peculiarities of the rocks, have been taken, and will be submitted for the inspection of the Legislature. The sections, profiles, and sketches, are intended to accompany the final report.

Thirty-four boxes of minerals, fossils, marls, peats, &c., have been collected, and forwarded to Trenton for examination, labelling, &c. But since the close of the field labors, there has not been sufficient time to make such an examination as is necessary before an accurate and complete report can be rendered on any particular locality or formation. I shall therefore only give a synopsis of such results of the investigation as may be particularly useful, and shall confine myself to that part of Sussex County in which the more detailed researches have been made.

GENERAL REMARKS ON THE PHYSICAL GEOGRAPHY AND GEOLOGICAL FORMATION OF SUSSEX COUNTY.

The physical geography of Sussex County, indeed, that of the whole northern division of the State, presents a striking contrast to that of the southern division; for while the latter resembles an extended plain, offering but little to attract the attention of the traveller, except its fertile fields and evergreen forests, the former is diversified with mountains, hills and valleys, affording that beautiful and varied scenery so characteristic of mountain districts.

There are three principal ranges, or series of elevated lands,

crossing the county in a northeasterly and southwesterly direction, viz.: the Blue or Kittatinny Mountain, extending along the northwestern boundary of the county, from the State of New York to Pennsylvania; the series of hills or ridges forming the Pochuck Mountain and Pimple Hill; and that part of the Highlands known as the Wawayanda, Wallkill and Andover Mountains, stretching along the southeastern border of the county.

Corresponding with the mountain ranges are three valleys, viz.: the valley of the Delaware, situated between the foot of the northwestern slope of the Blue Mountain and the Delaware River; the Kittatinny valley, ten miles in width, extending from the southeastern base of the Blue Mountain to the Pochuck and Pimple Hill range; and the valley of the Wallkill, situated between the latter and the Highlands. While the mountains are characterized by a rocky, meagre, and unproductive soil, and covered with trees of various species, and thickets of scrub oaks, the valleys are fertile, with a soil of alluvial and diluvial origin, easily cultivated, and bountifully rewarding industry.

The mountains, valleys and plains, are watered by numerous springs, lakes and rivers. The former are every where to be found on the elevated lands; and this, together with the peculiar adaptation of the soil to the growth of grass, renders the country admirably fitted to the rearing of fine stock, for which it is somewhat celebrated.

The numerous lakes, situated upon the highest lands, form a striking feature in the physical aspect of the country. They are sometimes one mile, sometimes several miles, in length and width; and they abound in the choicest varieties of fish. Among them may be mentioned the Wawayanda Lake, located upon the mountain of the same name, and which is a beautiful sheet of water about two miles in length, half a mile in width, and from ninety to one hundred feet in depth; the Machipaconk Lake, on the Blue Mountain, three quarters of a mile in length and half a mile in width; Cedar Swamp Lake, on the Blue Mountain, near the New York State line, and

thirteen hundred feet above the level of the water in the Delaware; Culver's, Swartwout's, Long, Morris's, and numerous other lakes.

The streams take their origin chiefly in the central part of the county, and empty their waters into the Hudson and Delaware rivers. Among them may be mentioned the Little and Big Flatkill, Paulin's Kill and Pequest, whose waters are emptied into the Delaware; and the Wallkill, with its numerous tributaries, as the Wawayanda, Warwick, Black, and Papakating creeks, emptying into the Hudson.

Its geological formations are as varied as its physical features. From the earliest period of the earth's existence, the two great dynamic forces, the igneous and the aqueous, have here alternately exerted themselves in forming and modifying its surface. At one time the waters of the ocean, teeming with animal life, covered its whole extent, and deposited the materials which now constitute its sedimentary rocks. At another time igneous agencies upheaved them from their ocean beds, forming the mountains and the valleys, filling the sedimentary deposits with rich ores and minerals, and thus here bringing together the three principal classes of rocks: aqueous, metamorphic, and igneous.

The aqueous rocks consist of a series of blue limestones of various shades of color, texture and composition; argillaceous, silicious, and calcareous slates and shales, and red, white, and gray sandstones, grits and conglomerates. They are composed of those series of rocks, denominated by the geologists of the New York survey, the New York System; and correspond with the Devonian and Silurian Systems of the English geologists. The most recent, or uppermost of this series, is a black fissile slate, called Marcellus Slate, the oldest member of the Erie Division of the New York System. This rock has but a very limited range in this State, occupying a bend of the Delaware River, which extends only three quarters of a mile below Shabacong Island; it then disappears beneath the alluvial matter of the island, and of the valley of the Delaware. Its greatest width is three hundred yards. It may be examined

on the farm of Peter Van Noy, about a quarter of a mile from the river, where a tunnel has been made in search of coal. Its color is very dark—almost a jet black; it is very fissile, and under the stroke of the hammer, it breaks into small pieces not greater than six or eight inches across. It contains iron pyrites, which on the exposed surface of the rock, having decomposed and covered it with an incrustation of the hydrous peroxide of iron, gives to it a brownish iron-rust color. A considerable quantity of this iron-rust, or hydrous peroxide of iron, has been carried down by streams of water and deposited along the banks of the river, and thus led many, erroneously, to believe that valuable deposits of iron ore are located in the vicinity.

The next series of rocks in the descending order, upon which the Marcellus Slate reposes conformably, is the Helderberg Series. This division embraces a series of limestones, varying in their lithological, chemical and fossil characters, by which they are subdivided into beds. Among the subdivisions occurring in this State which are well developed, and may be accurately defined by their characteristic fossils, may be mentioned (taking them in their order), the Corniferous, Onondaga, Encrinal, and Delthyris Shaly limestones, and Water Lime Group. They all abound in fossil remains; the most abundant being the encrinal, coralline, and testaceous remains; and each subdivision has some that are characteristic of it. They extend along the Delaware River from the New York State line to Walpack Bend, and vary from one mile to a mile and a half in width, composing that series of rolling hills and fertile ridges situated at the northwestern base of the Blue Mountain.

Directly under the Helderberg Series occurs the Ontario Division, of which the Medina Sandstone is well developed here (No. V. of Prof. Rogers), consisting of dark red sandstones and shales, occupying the northwestern slope of the Blue Mountain.

Next in the descending order occurs the Champlain Division, of which may be mentioned the following subdivisions:

1st. The Oneida, or Shawangunk Conglomerate, occupying the elevated portions of the Blue Mountain, and which is composed of a series of fine-grained silicious grits, coarse sandstones, and conglomerates made up of silicious matter from fine sand to pebbles of quartz three quarters of an inch in diameter; the Hudson River Group, composed of dark-colored slates, shales, thick-bedded and slaty calcareous grits, &c.; the Utica Slate, composed of dark-colored and argillaceous slates, furnishing in many places an excellent material for roofing; the Trenton and Black River Limestones; Calciferous Sand Rock, and Potsdam Sandstone. The above subdivisions of the Champlain Series, commencing with the Hudson River Group, occupy chiefly the Kittatinny and Wallkill valleys.

The metamorphic rocks are gneiss, hornblende slate, and white crystalline limestone. The latter occurs chiefly in the valley of the Wallkill, between the Wawayanda and Wallkill mountains, and the Pochuck and Pimple Hill range; the two former constitute the principal part of the rocks of the mountain ranges, as well as several parallel belts of the Wallkill valley.

The igneous rocks occur chiefly in the form of intrusive veins, dikes, and irregular masses of granite, syenite, and quartzose feldspathic rock, in the metamorphic, with the exception of a porphyritic granite which occurs protruding through the Hudson River Slate, and upheaving the Oneida or Shawangunk Conglomerate of the Blue Mountain near Beemersville, five miles northeast of Culver's Gap.

ECONOMIC GEOLOGY.

Among the various ores and materials of economical value occurring in the above formations are:

Magnetic iron ore;

Specular iron;

Limonite (hydrous peroxide of iron);

Iron pyrites;
Franklinite;
Red oxide of zinc;
Galena (argentiferous);
Sulphate of baryta;
Roofing slate;
Limestone for building and agricultural purposes;
Marble;
Calcareous sinter;
Shell marl;
Peat;
Kaolin (porcelain clay).

MAGNETIC IRON ORE—MAGNETITE—MAGNETIC OXIDE OF IRON—NATIVE MAGNET—LOADSTONE.

This ore, when pure, has an iron black color, and metallic lustre; is strongly magnetic; produces a black streak when rubbed on a surface of unglazed white porcelain, and gives a black powder when pulverized. Its composition is oxygen and iron—a combination of the protoxide and peroxide—72.4 of iron and 27.6 of oxygen. It may be readily distinguished from other ores of iron by its black streak and powder, and magnetic properties.

The description here given is that of pure magnetic iron ore, but this substance is very often associated with foreign matter, as quartz, mica, hornblende, feldspar, etc., which alter the color and general character of the ore, according to the kind, quantity, and texture of the foreign matter. It is one of the most valuable ores of iron; and from it the greater part of the iron of this State is manufactured. It occurs in veins and beds, and is disseminated through igneous and metamorphic rocks. In this district it occurs chiefly in the igneous and metamorphic rocks of the Highlands, and valley of the Wallkill.

The following are among the most important localities:

WAYWAYANDA MINE.

This mine is situated on the Wawayanda Mountain, half a mile from the New York State line, and two and a half miles northeast of the Wawayanda Lake. The prevailing character of the rock, in which the ore occurs, is gneiss. It is exceedingly variable in composition and texture. Mica enters but slightly into any of the rocks throughout the whole mountain, and in many places it is entirely absent. When entirely absent, hornblende, or magnetic iron ore, in grains, takes its place, forming a syenitic gneiss. The rock in some places is composed only of feldspar and quartz, the former being its principal ingredient.

Four deposits of ore have been opened and worked. Their prevailing course is northeast and southwest, and their dip from twenty to forty degrees to the southeast.

Commencing at the southeasterly deposit, and taking them in their numerical order, we find that the first is not worked at the present time, and has not been for several years, because the ore is more accessible and more abundant in the other deposits. On account of the water in the shaft, and the dilapidated condition of its timbering, I was unable to make a personal examination, but I was, however, informed by the mining captain, that it has been worked to the depth of one hundred and ten feet, and one hundred on the deposit; and that the ore is from twelve to fourteen feet in width, at the bottom of the shaft.

The second deposit occurs fifty feet northwest of the first. It has been worked to the depth of eighty feet, and one hundred feet on the deposit; and at its present depth is thirty feet in width.

The third deposit is seventy-five feet from the second. Here the ore occurs in the form of a bed, or irregular deposit, varying from two to twelve feet in width. At its present depth, one extremity of the workings shows the ore six feet in width, and the other two feet.

The fourth deposit, forty-five feet from the third, is from four to five feet in width, and has been worked to the depth of sixty-five feet.

About a quarter of a mile southwest of the Wawayanda Mine, on the property of Mr. Green, openings have been made into the third and fourth deposits, from which a large quantity of ore has been taken. All these deposits are exceedingly irregular, having no well defined walls. They occur between two strata of gneiss of different characters. The underlying stratum is generally a very hard and crystalline syenitic gneiss; the overhanging is chiefly composed of feldspar and quartz; the former in large imperfect crystals and greatly predominating. They are frequently displaced and altered by dikes of granite, which in some cases are injected into the deposit, and in others, cut it off entirely and throw it aside. Numerous sketches and sections illustrating the dislocations have been taken, and will accompany the detailed description of this mine in the final report, together with the composition of the ores, metallurgy, etc.

The ore from this mine is of an excellent quality, a large proportion of it being entirely free from foreign substances. It is highly magnetic, and possesses polarity. Iron pyrites sometimes occurs in very small quantities at the junction of the dikes and ore, which renders them easy of separation. It is chiefly smelted in a charcoal furnace upon the borders of Wawayanda Lake, and produces an iron peculiarly adapted to the manufacture of car wheels. Almost all of it is consumed by Whitney & Son, of Philadelphia, for this purpose. The mine and furnace are owned by Oliver Ames & Sons, of Boston, who commenced operations here about nine years ago. Until January last the work had been suspended for about four years, and since this time has been carried on with great activity.

Following the course of the Wawayanda Mountain towards the southwest, indications of the existence of magnetic iron ore are every where visible. In some places it is disseminated in grains through the rock, forming one of its constituent min-

erals; in others it occurs in "strings," or small veins, from one to several inches in width. In some places, large deposits are indicated by the magnetic needle.

OGDEN MINE.

The next important deposit of magnetic ore which has been opened and worked, is upon the Wallkill Mountain, three miles southeast of Franklin Furnace. It was opened in the year 1772 by Abram Ogden, and has since then been worked, at intervals, by different parties, its name always changing with the name of its proprietor. It has been known, at various times, by the name of Kinney's, Sharp's, and Bird's Mine. At present it is owned by the New Jersey Franklinite Company, and worked by Edward De Camp, of Charlottenburgh, whose name it bears. The ore occurs in the form of an irregular vein or deposit varying from ten to thirty feet in width. Its general course is northeast and southwest, and its dip is at an angle of ten degrees to the southeast. It is now worked forty feet from the surface, and is fifteen feet in width. The ore which it yields is of a variable quality, some being entirely free from foreign substances, while with a large proportion of it may be found the constituent minerals of the gneiss, and, in some cases, iron pyrites in small quantities. This ore is smelted in Hopewell Forge.

VULCAN MINE.

This mine is situated on Vulcan Head, on the property of Richard R. Morris, Esq., about half a mile southwest of the Ogden Mine. Two deposits of ore have been opened by means of shafts sunk to the depth of thirty feet. The first shaft exposes a mass of ore ten feet in width, dipping towards the southeast at an angle of fourteen degrees. The ore is highly magnetic, and contains a considerable quantity of feldspar and iron pyrites associated with it. The second shaft

exposes a mass of ore nine feet in width, associated to a considerable extent with grains of quartz and feldspar; but free from iron pyrites. Small specks of carbonate and sulphuret of copper are disseminated through some parts of it, but not in a sufficient quantity to injure it as a furnace ore, for which it will answer an excellent purpose.

Following the summit of the Wallkill Mountain towards the southwest, I observed many indications of large deposits of ore. Undoubtedly very extensive beds may be opened in this vicinity, which at no distant day will prove a source of great profit to their proprietors.

SHERMAN'S MINE.

This mine is situated on Slack Brook, three quarters of a mile southeast of Sparta. Several deposits of ore are exposed on either side of the brook, varying from three to ten feet in width. They are very irregular, having no well defined walls, and, in many places, it is difficult to ascertain their limits, because the ore is disseminated to a considerable extent through the adjoining rocks.

SPECULAR IRON—PEROXIDE OF IRON—RED IRON ORE—RED HEMATITE.

This ore of iron, when pure, has a metallic appearance; is of various shades of color, and is composed of seventy metallic iron and thirty oxygen, in one hundred parts. It is easily distinguished from other ores of iron by its reddish streak and powder. In nature it rarely occurs in a pure state, but generally mingled with lime, silica, alumina, &c., when its value depends on the nature and proportion of the foreign material. It is generally found in beds or irregular deposits associated with igneous and metamorphic rocks, more frequently in the latter, or at the junction of the two. A great part of the iron manufactured in different countries is from this ore, and al-

though it requires much more heat to smelt than other ores, yet it produces an iron of excellent quality.

In this district this ore occurs in the white crystalline limestone, and is generally found at or near the junction of that rock with gneiss, syenite and granite. Large bowlders of it are found all along the southeastern border of the white limestone formation from the New York State line across the State to Pennsylvania. A careful examination of the district will undoubtedly be the means of developing extensive deposits of this valuable ore. Among the localities that have already been worked to a considerable extent, I will refer to but two, viz.,the Simpson and Andover mines.

SIMPSON MINE.

This mine is in Vernon Township, half a mile from Smithville, and two and a half miles northeast of Hamburgh. The ore occurs in the form of a bed or irregular deposit, from six to ten feet in width, in the white limestone. Excavations have been made into it to the depth of twenty feet, from which considerable quantities have been removed and smelted in the old Hamburgh Furnace, yielding an iron of superior quality. This ore has a brownish red color, a fine steel-grained texture, and a metallic lustre. A large proportion of it is quite pure and almost entirely free from foreign materials.

ANDOVER MINE.

This mine, celebrated as one of the oldest and richest iron mines in this country, is in the township of Newtou, near the village of Andover, and in the same geological range and formation as the mine last mentioned. It has been worked at different times from the year seventeen hundred and sixty to the present, and is noted for furnishing an ore peculiarly adapted to the manufacture of steel.* The ore occurs in the

* Hon. Jacob W. Miller's address before the New Jersey Society, 1854.

form of a large irregular deposit, from sixty to eighty feet in width, and forms the southwestern side of a hill rising upwards of one hundred and fifty feet above water level, and from which during the last seven years over one hundred and twenty thousand tons of ore have been removed. The principal part of the ore is specular iron of different shades of red, gray and blue, and of various qualities. Its color, texture and lustre depend chiefly on the foreign materials with which it is mingled, among which are carbonate of lime, alumina, silica, magnesia, manganese, and magnetic oxide of iron. The following are the statements and analyses which Mr. James C. Kent, the chemist of the Trenton Iron Company, has, at my request, been kind enough to furnish me:

"OFFICE COOPER IRON WORKS,
December 15, 1854.

"The Andover mines, situated at Andover, Sussex County, New Jersey, were originally worked by an English Company prior to the Revolutionary War, from which period up to the year eighteen hundred and forty-seven, they remained unworked. In the latter year they were purchased by Peter Cooper, Esq., for the Trenton Iron Company, who have since continued mining, and, in seven years, have taken from them upwards of one hundred and twenty thousand tons of ore.

"The ores are principally the peroxide of iron, and the chief varieties are the 'blue' and 'red.'

"The following analyses, selected from a number I have made at different periods, give the composition of the varieties above mentioned.

	Blue.	Blue.	Red.	Red.
Peroxide of Iron,	90	70	65	70
Oxide Manganese,	3	2	4	10
Carb. Lime,		16	16	12
Silica,	6	8	10	6
Alumina,			2	
Magnesia,			1	
	99	99	99	99

"There are other kinds of ore occurring in smaller quantities. I subjoin analyses of the most interesting:

	Brown Ore.	Resinous Ore.	Carbo Silicate of Manganese.	
Peroxide Iron,	30	40	Protoxide Manganese,	34
Carb. Lime,	35	12	Lime,	11
Silica,	30	30	Silica,	33
Alumina,	3	3	Alumina,	1
Oxide Manganese,		15	Protoxide Iron,	1.5
			Carbonic Acid,	18
	98	100		98.5

"These ores, though not unusually rich, are remarkable for the facility and rapidity of their reduction in the smelting furnace.

"The large quantity of the best fluxing materials, such as manganese and carbonate of lime, contained in the ore themselves, renders necessary the small addition of but ten per cent. of fluxing matter in working the ores in the furnaces.

"In one of our furnaces (forty-two feet high and eighteen feet across the boshes), we have made two hundred and thirty tons of pig iron per week for six weeks in succession, with one and a half tons of coal per ton of iron; and the yield for a single week in one furnace has been as high as two hundred and fifty-one tons, an amount unprecedented in the annals of European furnaces. A considerable proportion of the iron produced is of the kind termed 'lamellated.' This iron is a type of the perfect combination of carbon and iron, with the carbon in larger proportion than in any other kind of iron. This species presents in the fracture a silvery brightness, and is beautifully crystallized, some of the crystals having brilliant faces, measuring two inches across. Another variety is the 'radiated,' which presents a fibrous fracture, the fibres radiating from the centre to the outside of the pig.

"The pig iron made at the furnace is puddled at the Rolling Mill of the Company, and the anthracite blooms thus made are converted into the various kinds of bar iron, rails, &c. At

the wire mills the blooms are worked and drawn down to the finest wire, unsurpassed in quality; steel of the best description is also produced from the iron; and when wrought iron of great strength and toughness is required, as in the shafts for our largest class steamers, the Andover iron has been thoroughly tested and pronounced unrivalled.

"The Trenton Iron Company have three furnaces at present in operation, requiring to supply them sixty thousand tons of ore per annum. A large proportion of this ore is taken from the Andover mines, yet notwithstanding this heavy demand upon them, the mines promise to yield for many years to come an abundant supply.

"JAMES C. KENT."

LIMONITE—HYDROUS PEROXIDE OF IRON—BOG IRON ORE—YELLOW CLAY IRON STONE.

This ore, when pure, is composed of the hydrous peroxide of iron, and contains about sixty parts of metallic iron in one hundred. It almost always occurs mixed with foreign substances, as lime, alumina, silica, &c., which give to it a variety of forms, and from which its name is derived. Its prevailing colors are various shades of brown and yellow; and its streak and powder are yellow brown. The variety called bog ore sometimes contains phosphorus, and yields a cold short iron, unfit for those purposes which require a tough tenacious metal, but admirably adapted for casting. This ore, in its various forms, occurs in beds associated with rocks of all ages. In this district the greatest deposits are found among the metamorphic rocks of the Wallkill Valley. Bog ore occurs, not unfrequently, in the Blue Mountains, and in the valley of the Delaware, but not in sufficient quantities to be of much practical importance.

On the farm of Chandler Wood, half a mile southwest of the New Turnpike, on the Blue Mountain, is a bed of this ore apparently of considerable extent. It is situated in a marsh at

the foot of a sandstone ridge. Its origin may be undoubtedly traced to the iron pyrites which abounds in the sandstones and grits of this mountain, and which, being decomposed, is carried down by the water, and deposited in the low, swampy lands situated at the base of the ridges.

POCHUCK MINE.

Two miles and a half northeast of Hamburgh, between the base of the Pochuck Mountain and a ridge of white limestone, occurs an extensive bed of brown hematite in stalactitic, mamillary and botryoidal forms, of a fibrous and massive structure. Excavations have been made on the surface, two hundred yards in breadth, and from sixty to eighty feet in depth, from which large quantities of ore have been taken, and smelted in the Hamburgh Furnace. The greater part of the ore occurs in concretionary masses embedded in clay and sand, also in beds of clay of various colors, which have been formed by the decomposition of a quartzose feldspathic rock. Large masses of a quartzose rock, of a honeycomb or cellular structure, containing fibrous limonite of a very pure quality, are associated with the above, having been apparently subjected to an intense heat. This mine has not been worked for a number of years, on account of great depression in the iron business.

EDSALL MINE.

Two miles northeast of Upper Hamburgh, another extensive bed of limonite has been worked. It is situated in a slight depression between the base of the Wallkill Mountain and a small knob of highly ferruginous feldspathic gneiss. Excavations have been made two hundred feet in length and breadth on the surface, and forty feet in depth. The ore is of the same general character, and associated with the same soft feldspathic rock as in the Pochuck Mine.

In following the course of the Wallkill Valley, along the base of the mountain towards the southwest, limonite may be seen in numerous places, mingled with the soil, indicating the existence of other beds, of equal extent and value, through this district. Examinations for this ore should be made at the base of the mountain, in depressions and valleys, and in the vicinity of the white or metamorphic limestone.

FRANKLINITE AND RED OXIDE OF ZINC.

Franklin and Sterling Hill in this district, have long been celebrated for the intricacy of their geological formations, their numerous rare minerals, and extensive and valuable metalliferous deposits. They have attracted men of science from all parts of the world, with a view to collecting specimens with which to enrich their cabinets, and to turning the inexhaustible quantities of franklinite and red oxide of zinc to some practical purpose. Although, from time to time, many attempts have been made to render them available for the manufacture of zinc, iron, or some of their compounds, it was not until within a few years that any favorable results have been obtained. These are among the most valuable contributions which have been made for many years to metallurgical science, and will be long regarded as illustrations of American enterprise and perseverance.

The nature of this report will simply allow the observation that the franklinite and zinc ores are among the extensive and valuable resources of this part of the State. Sketches, maps, sections, etc., illustrating their geology, mineralogy and metallurgy, have been carefully prepared, and will accompany full and detailed descriptions of them in a future report.

FRANKLINITE.

This ore occurs massive, of a compact, coarse and finely granular structure, also crystallized in octahedrons. It has an

iron black color, metallic lustre and a dark reddish brown streak and powder, and acts slightly on the magnet. It is composed of iron, manganese and zinc, containing, according to Berthier, of oxide of zinc, 17; of iron, 66; and of manganese, 16 parts; and, according to Dickerson, of oxide of zinc, 21.77; of iron, 66.12; of manganese, 11.99; and of silica, 0.13.

RED OXIDE OF ZINC.

This ore occurs in masses of a granular and foliated structure, also in grains mechanically associated with franklinite, and disseminated in white crystalline limestone. It has a dark red color, and orange yellow streak. When pure, it contains, according to Whitney, 19.74 oxygen, and 80.26 zinc in 100 parts, but it also contains a small per centage of oxide of manganese, to which its red color is ascribed.

These two ores have been found in no country but this, and in no region of it except at Franklin and Stirling Hill. Here they occur in extensive deposits, associated together, and connected with the white crystalline limestone. At Stirling Hill there are two of these deposits from three to fifteen feet in width. Their general course is northeast and southwest, and their dip forty degrees to the southeast. The red oxide of zinc, mechanically associated with franklinite, and, in places, disseminated to a greater or less extent through the limestone, occupies the upper portion of the deposit, while the lower portion is composed of grains and crystals of franklinite mechanically associated with willemite (silicate of zinc), disseminated through the limestone. The greater, or southeasterly deposit, occurs in a limestone bluff, which rises abruptly from one hundred and fifty to two hundred feet, forming a steep southeastern slope. It has been worked four hundred yards on its outcrop, in one place, on the property of the New Jersey Zinc Company, to the depth of two hundred feet. Near the surface, the zinc portion of the deposit was from two to three feet in width; at its present depth it is from six to eight feet in width, and

affords an excellent quality of ore. The franklinite portion of the vein is very irregular. In one place it is from fifteen to twenty feet in width, and of a remarkably pure quality; but, in either direction from this spot, it becomes thinner, and, in many places consists of a few crystals of franklinite very sparingly disseminated through the limestone. The second, or northwesterly deposit, has been recently opened on the property of the Passaic Company. It has been worked to the depth of about forty feet, and as yet does not exhibit the regularity found in the former. A tunnel is now being driven into the base of the hill, which will strike the deposit about ninety feet from its outcrop.

At the present time, two companies are engaged in mining the zinc ores of this locality, and in manufacturing directly therefrom the white oxide of zinc. The one is called the New Jersey Zinc Company, and the other the Passaic Zinc Company. The former was organized in 1848; and their works, situated in Newark, are in successful operation, producing annually between three and four thousand tons of the white oxide of zinc, which is sold as a paint, and is preferred for many purposes to white lead. A small furnace has been recently erected at their works, in which the refuse matter, chiefly franklinite, is smelted for iron.

The works of the Passaic Company have been recently established at Jersey City, where preparations have been made for manufacturing the white oxide on an extensive scale.

The only remaining locality at which these ores have been found, is at Mine Hill, in Franklin, where the franklinite greatly predominates over the other mineral. Two extensive deposits have been exposed, and worked to a considerable extent, crossing Mine Hill for a distance of three quarters of a mile in a northeasterly and southwesterly direction. They occupy the summit of the hill, which rises one hundred and fifty feet above water level; and to this depth the ore may be removed at a trifling expense. The following section on the southwestern slope of the hill, commencing at the northwest, and crossing the formations towards the southeast, represents the relative position of the two deposits of ore.

1. Syenite.
2. Magnetic iron, from two to six feet in width.
3. White Limestone, from four to ten feet in width.
4. Franklinite, twenty feet in width.
5. White Limestone, sixty feet in width.
6. Franklinite, twenty feet in width.
7. White Limestone.

The latter deposit of Franklinite (6) has been recently exposed for several hundred yards on its outcrop, exhibiting a mass of nearly pure ore, varying from twenty to fifty feet in width. At an opening in the deposit at the northeastern part of the hill, a considerable quantity of red oxide of zinc is mixed with the franklinite; as far, however, as the deposit is exposed, but very little zinc occurs. The magnetic iron ore (2) herewith associated, has been formerly worked to a great extent, yielding large quantities of excellent ore which was smelted in the old Franklin Furnace.

The New Jersey Franklinite Company, organized in 1852, is actively engaged in erecting furnaces and suitable buildings within a few yards of the deposits, for the purpose of smelting the ore, which will at the same time yield a superior article of iron as well as the oxide of zinc. One furnace is nearly completed, and will be put into operation in the course of a few weeks. The iron manufactured from the franklinite ore is of an excellent quality, and peculiarly adapted to the production of the best kind of steel. There are many circumstances which render Franklin an admirable location for the successful prosecution of an enterprise of this character. It not only furnishes an inexhaustible quantity of ore, but with the exception of fuel, every other article required in the manufacture of iron and zinc. Building materials of every description, including granite, marble and sandstones; clay for the production of bricks; limestone for plaster, masonry, &c., are in abundance. In addition to all these advantages, nature has here also furnished a never-failing water-power, by which operations of every kind may be greatly facilitated.

SHELL MARL—CALCAREOUS SINTER—CALCAREOUS TUFA—TRAVERTIN.

These terms are applied to deposits of lime from solution in water. They occur generally in springs, ponds, shallow lakes and low marshy lands. Water holding carbonic acid gas in solution, has the property of dissolving carbonate of lime, which is deposited in the form of a fine powder, whenever the carbonic acid gas escapes. This gas is held in solution by rain water, and many spring waters, which, in percolating through limestone rocks, or in passing over their surface, dissolve a portion of the lime, and carry it into ponds, lakes and marshes, where it is deposited in the form of a white calcareous powder. It is there absorbed and secreted by testaceous animals, whose outer covering, or shell, is thus formed. In those situations where a large quantity of calcareous matter is held in solution, these small testaceous animals grow in great abundance, and live but a short time, their places being taken by other generations, which in turn die; and thus large deposits are formed, called *shell marl.* In those situations where but little calcareous matter is held in solution, new generations of testacea, in forming their own shells, consume those of preëxisting ones, and thus the rapid accumulation of shells is retarded. And, again, where a superfluous amount of carbonate of lime is held in solution, which is very often the case in limestone districts, the lime is deposited with the testaceous remains, which still more rapidly increases the deposits. Shallow ponds, or lakes, where the deposition of shells and lime is rapidly carried on, finally become filled up to the water line; so soon as the water passes off, peat begins to form, and by its annual growth and decay, a deposit of this material is quickly accumulated upon the marl. When in such cases, the peat begins to form on the surface, the testaceous animals do not cease to exist, but on the contrary, continue generation after generation to increase the deposit of marl under the peat, while at the same time the peat is continually

increasing upon the surface. It is in this form that extensive deposits of marl occur in almost every part of this county. Wherever such deposits have been examined, they are usually found to rest upon a bed of clay, sand or gravel, and are succeeded by muck or peat. At or near the junction of the peat and marl, a layer of living testacea generally occurs, mingled with the peat. From twenty-five to thirty inches below this, the living animals disappear, their places being occupied by their remains in a decomposed state. The shells most frequently found in these deposits are the Limnea jugularis, Valvata tricarinata, Cyclas similis, Planorbis bicarinata, and some other species.

Springs holding a large quantity of lime in solution, sometimes deposit it on the surface in the form of a loose porous mass. It often happens that twigs and leaves are enveloped in these deposits, and their impressions thus preserved in a most beautiful and perfect manner. Such deposits are called calcareous sinter, calcareous tufa or travertin. Extensive deposits of calcareous sinter and shell marl are found in every part of this county. The most important localities are in the limestone districts. A large deposit of shell marl is found along the course of Chambers' Mill Brook, in Montague Township, on the farm of Isaac Bonnell, Esq. This deposit covers an area of from seventy-five to one hundred acres. It is situated in a low meadow or marshy land, surrounded by limestone hills; and this meadow has, at one time doubtless, been covered by a shallow lake or pond. Near the centre of the deposit, an examination was made to the depth of eighteen feet, giving the following section:

Peat and muck, 3 feet.

Marl and peat containing living testacea, 4 feet.

Marl, very fine, made up of decomposed shells, 11 feet.

The instrument not being of sufficient length, the whole thickness of the deposit was not ascertained. In other places where examinations were made, the peat was found to be from five to ten feet in thickness; and from six to ten feet from

the surface, were found embedded the branches and trunks of trees from one to two feet in diameter.

On the Little Flatkill, two miles southeast of the town of Montague, upon the property of I. Cole, Esq., is found another deposit, covering an area of fifty acres. The peat resting upon the marl, is from four to six feet in thickness; and the marl from six to eight feet, resting upon a bed of sand and gravel. On the farm of Mr. Isaiah Vannetten, one mile and a half northeast of Hainsville, is another deposit covering an area of twenty acres, and overlaid by a deposit of peat from three to eight feet in thickness. On the farm of Mr. Benjamin P. Van Syckle, in Sandiston Township, three miles northwest of Tuttle's Corner, and two miles southeast of Dingman's Ferry, is found a deposit of calcareous sinter, covering an area of at least five acres. It is exposed on either side of a small stream to the depth of several feet. A well fifteen feet deep has been dug into it without passing through its whole extent. Though very hard and compact upon the surface, it becomes softer and more pulverulent as it descends. In it are found numerous nodules, or concretionary masses, which have been formed by the deposition of the lime around a twig or some other substance as a nucleus for the aggregation of calcareous particles. The source of this deposit may be traced to a spring, half a mile distant, near the house of Mr. James Struble. This spring issues from the base of limestone ridge, and empties into a small reservoir or pond, whence it passes to Mr. Van Syckle's land. In the bottom of this reservoir grows the Chara, a genus of aquatic plants. While growing at the bottom of ponds and streams, it has a dark green color, but upon being removed and exposed directly to the atmosphere, it soon becomes white and crumbles to a fine powder composed chiefly of the carbonate of lime. Large quantities of it are constantly forming at the bottom of this pond, and it requires to be removed, from time to time, in order to prevent the pond from being filled by its rapid accumulation.

Another extensive deposit of calcareous sinter is found on the limestone slope at Dingman's Ferry, a little above the

Delaware River. It covers an extensive area, and is from fifteen to twenty-five feet in thickness, as may be seen by examining either side of a small stream passing through it, and from which the calcareous matter has been deposited. On the surface, where it is exposed directly to the atmosphere, it is very hard, and emits a ringing sound when struck with the hammer. A few feet from the surface it is soft and pulverulent, and of a light gray color. It contains numerous beautiful and perfect impressions of leaves, branches, etc.

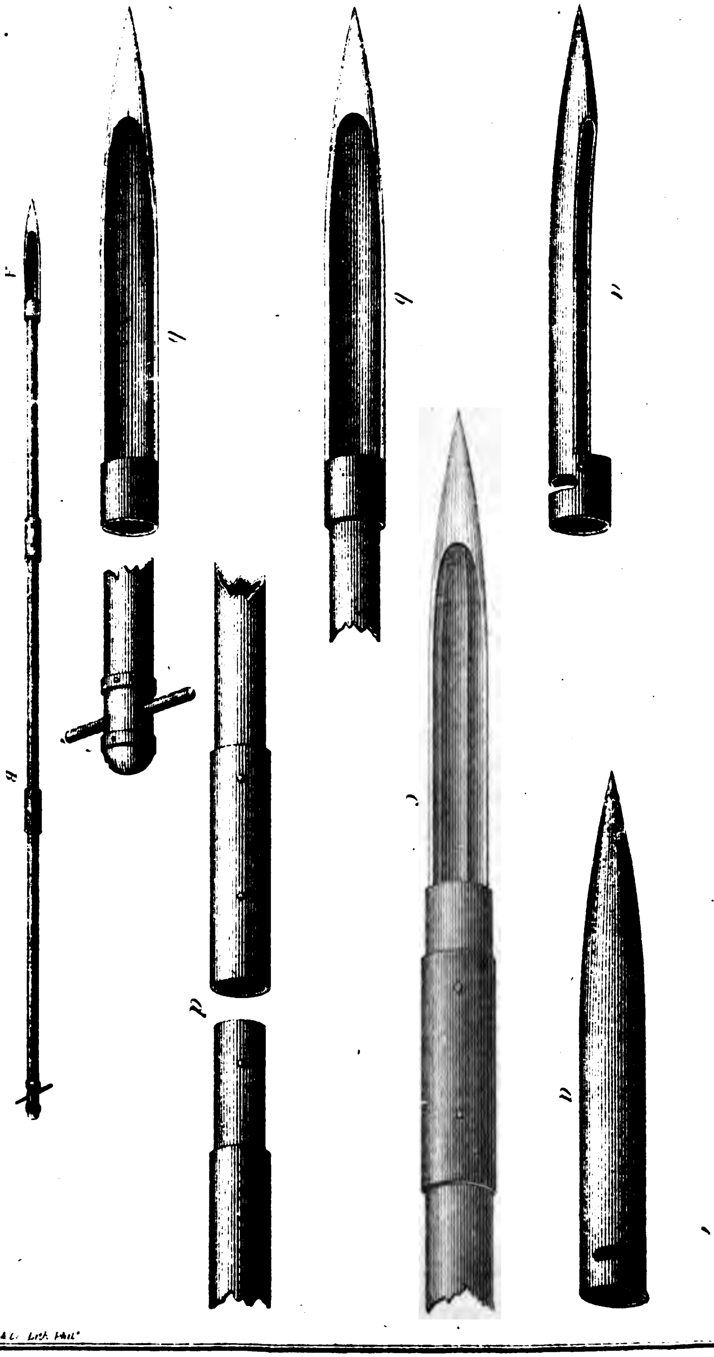
Inexhaustible quantities of marl and calcareous sinter may be obtained from the above localities at a comparatively trifling expense.*

In the Kittatinny and Wallkill Valleys, deposits of marl are numerous. They are found several feet in thickness, at the bottom of the lakes and ponds, marshes, and meadow lands so abundant in these districts. A very common name for these small collections of water is "White Pond," of which several are so called in the county. This name is given to them on account of the deposits of shells distinctly visible at their bottom.

Peat and marl are found in abundance in Vernon Township, on Black Creek, the meadows opposite the town of Vernon covering an area of several hundreds of acres. The peat here varies from four to fifteen feet in thickness, and the marl from one to ten. Numerous other localities have been noticed and will be referred to in a future report.

Deposits of marl occur most generally in peaty meadows and marshes; and in such places may be easily examined by thrusting through the surface a pole or rod, to which the marl, if present, will adhere. It may also be done by means of a spade or shovel; but the examination is sometimes tedious, on account of the presence of water, which often removes the marl from the pole, or renders the use of the spade laborious. An instrument admirably adapted to such examinations has been employed during the past year. It is so con-

* For analyses of specimens from each, see the annexed Report of Mr. Wurtz.



P. S. Duval & Co. Lith. Phil.

structed that a quantity of peat, marl, soil, etc., may be taken from any depth without mixing it with the other materials surrounding it.

The accompanying figures will give an idea of its construction: A B is the whole instrument, sixteen feet in length. A is its point or borer; B its handle. The point or borer, A, is twelve inches in length, and one inch and a half at its greatest diameter. It is formed of two half cylinders, an exterior, *a*, and an interior, *b*. They are so arranged that when put together, as at *c*, the exterior rolls upon the interior, causing the whole to present the form of a conical or tapering cylinder. The handle is made of strong wood, and in detached portions, four feet in length, which may be connected at pleasure, by means of an iron band, as at *d*. The object in having the handle in detached portions is for convenience of transportation, and for increasing its length as circumstances may demand. The instrument being closed, as represented at A B, it is forced into the peat or marl to the depth at which the examination is to be made; then by turning the handle to the right, the pressure on the exterior cylinder, forces it behind the interior, and in this manner the instrument is opened. It is then forced downward six or eight inches, or the length of the cylinder, when the hollow becomes filled. The handle being then turned towards the left, the cylinder encloses a portion of peat or other matter taken from the spot where the instrument stopped. Its precise depth is indicated by the number of feet and inches represented on the handle.*

USE OF SHELL MARL AS A MANURE.

In Europe, as well as in some parts of this country, shell marl has long been considered one of the most valuable of fertilizers. It not only possesses every property of lime in

* For a description of this instrument, from which it was made, I am indebted to Leo Sesquereaux, of Columbus, Ohio, a gentleman who has made extensive examinations of the peat and coal lands of Europe and this country.

its action upon soils, but it very often contains phosphoric acid, ammonia, organic matter, and other substances which increase its value.* Its principal constituent is carbonate of lime, in the form of what is called "mild lime," because free from that causticity which quicklime, slaked by water or air, possesses, and which is very often injurious to soils. Its pulverulent state gives it an advantage over lime, for it simply requires to be removed from the deposits and spread on the land, or composted with muck or peat, or exposed in heaps for a time, as circumstances may demand; while lime, before it can be applied to soils, must be quarried, burned, slaked, &c. It may be advantageously employed in certain forms and quantities, and under proper circumstances, to all soils. The quantity and form in which it should be applied is indicated by the character of the soil. On peaty soils, or those which contain a large amount of vegetable matter, it may be used in great quantities, either by spreading it broad cast, directly after taking it from its bed, or after it has been drawn to some convenient place and suffered to remain in heaps exposed to the air, six or eight months; or even after it has been burned and slaked like limestone. In the latter case it becomes caustic lime, and should be used only upon soils which contain a great quantity of inactive vegetable matter, as is often the case in low peaty lands, or where there is a large deposit of muck. Such lands are abundant in Sussex County. They are chiefly situated in springy places, on streams, etc., as the numerous peat and bog meadows on the Little and Big Flatkill, the drowned lands on the Wallkill, the marshes and swamps on the Paulinskill, Black and Papakating creeks, and, in fact, on all the streams, large and small, in the county. There are thousands of acres of such lands in this part of the State, lying perfectly useless, and in many cases generating malarious diseases, which, on being reclaimed by thorough drainage and a free use of lime, would be deprived of their malarious poisons, and rendered the most productive soils in the State.

* See analysis by Mr. Wurtz in the annexed report.

In the use of lime as a fertilizer, it may be established as a general rule, that it is only to such lands that it should be applied in its caustic state.*

Shell marl, either alone or composted with peat and muck, may be advantageously used in large quantities on clayey, sandy, and loamy soils. The principal object in composting it with peat and muck is, at the same time, to add organic matter to the soil. If the soil contains already a sufficient quantity of organic matter in an active or proper state, it may be applied alone. Its mechanical action on many soils, particularly on hardpan, or clayey soils, rendering them more pulverulent and open, is of great importance. It may be advantageously employed upon poisonous soils. Copperas or sulphate of iron renders land sterile. Whenever a soil is derived from the debris of a rock wherein is found iron pyrites, (sulphuret of iron,) it will contain sulphate of iron, and very often in sufficient quantities to destroy vegetation. An instance of this was observed in Frankford Township, near the County Poor House. In its vicinity was a ridge of slate containing a large amount of pyrites, which, being very soft, is constantly undergoing decomposition, and forming sulphate of iron, and this is carried over the soil and mingled with it by the wash of the ridge.

To a calcareous soil, or one which has been formed from the debris of limestone rock, it may be applied in small quantities alone, or composted with large quantities of vegetable matter. On the northwestern slope of the Blue, or Kittatinny Mountain, the course of the Little Flatkill is near the dividing line between the limestone of the Helderberg Series, and the red sandstone and shales of the Medina Sandstone. The soil on the limestone hills between the Little Flatkill and the Delaware

* By caustic lime, is understood the hydrate of lime, or that form produced by slaking freshly burned or quick lime with water. Its caustic property is greatest directly after being slaked. From that time the carbonic acid of the atmosphere, uniting with it, drives off the water, and taking its place diminishes its caustic property. This action continues until all the water is driven off, and it becomes carbonate of lime, or mild lime.

River is chiefly of a loamy, calcareous nature, formed by the disintegration of the various kinds of limestone and sandstone bowlders which are very abundant over its surface. On the other side of the Little Flatkill, between it and the summit of the mountain, the soil is of a sandy nature and deficient in organic matter. On this soil the shell marl, either alone or composted, would be of great advantage. On the other side of the Kill it should be applied, as a general rule, in smaller quantities, together with vegetable matter. Thus it will be seen that various circumstances, such as the nature and character of the soil, manner and form of application, &c., should guide us in the use of this material as a fertilizer; and when all these things are properly considered, it will undoubtedly prove a cheap and effectual means of enriching the soils of this county. It may be used to a certain extent in place of gypsum, of which there has been a great consumption here. By referring to the analyses of Mr. Wurtz in the annexed report, it will be observed that this material, (sulphate of lime or gypsum,) is sometimes found as one of its constituents. No general rule can be given in regard to the quantity of marl which may be applied per acre. This must depend on the various circumstances to which we have already referred, as well as on the composition of the marl, its per centage of carbonate of lime, &c.

Although this valuable fertilizer is found in such extensive and accessible deposits in every part of the county, it has been but very little used. This is doubtless owing to the injudicious manner in which trials of it have, from time to time, been made. On account of its great accessibility, and through ignorance of its nature, it has been applied in such large quantities as to destroy vegetation and render the soil sterile for a number of years. On the property of Mr. James H. Struble, in Sandiston Township, is a barren spot of land to which marl, or calcareous sinter, was applied eighteen years ago. Since this time, as I was informed, no vegetables would grow except when a heavy coat of barn-yard manure, or vegetable matter, is applied to it, and then but one luxuriant crop can

be obtained. This experiment not only proves the injurious effects of too large a quantity of this material, but it also speaks volumes in its favor. It has been used by Mr. Van Syckle, in this vicinity, and by others in different parts of the country, with great success. These facts, together with the high estimation in which it is held in the State of New York, and wherever it has been extensively and judiciously used, should be sufficient to dispel the prejudice so prevalent among the farmers of this county, that it acts as a poison to vegetation.

I am, Sir,
Your very obedient servant,
WILLIAM KITCHELL.

NEWARK, N. J., *January* 15, 1855.

REPORT

OF PROFESSOR GEORGE H. COOK, ASSISTANT GEOLOGIST.

To Dr. Wm. Kitchell, Superintendent of the Geological Survey of New Jersey:

DEAR SIR:—In pursuance of my duty as Assistant Geologist, charged with the survey of the southern part of the State of New Jersey, I respectfully submit the accompanying Report.

The instructions received were to make a geological survey of the eastern half of Monmouth County, and report upon the same at the close of the present year. In accordance with these, the survey has been prosecuted either in the field or in the laboratory from July twenty-seventh to the present time. It has not yet been brought to a conclusion, but is in such condition that it can be completed at an early day.

At the commencement of a survey of this kind, many of the examinations must be of a general character, and such as have a bearing upon all the work which is to follow. For this reason, while the main part of my examinations have been made in the eastern part of the county, I have made one excursion to its western part, and another entirely across the State, and down to Salem. I trust that the work already done will be found useful, and that the foundation is laid for prosecuting the survey with accuracy and dispatch.

Very respectfully,

Your obedient servant,

GEO. H. COOK.

RUTGERS COLLEGE, *December* 30, 1854.

REPORT.

GENERAL REMARKS.

That part of New Jersey which, in the Geological Survey, is assigned to the southern division, includes all that portion of the State lying south of a line drawn from Staten Island Sound, near Elizabethport, to the Delaware River, a little below Trenton. The line follows the southeastern border of the red shales and sandstones which stretch across the central part of the State. Its general direction is straight, and its bearing a little west of southwest. The extreme length of the district is one hundred and ten miles, and its greatest breadth about seventy-five miles. Its area is estimated at not far from three thousand four hundred square miles.

In its physical geography, it is remarkable for its lack of hills, its sandy soil, its extensive pine woods, and for the almost entire absence of rocks.

The Nevisink Hills are three hundred and ten feet high,* and a chain of hills of a somewhat less elevation extends from them in a westerly direction to Freehold. South of these the country seldom rises more than sixty feet above the level of the sea.

A belt of clayey or loamy soil, several miles in width, extends across the northern border of the district, and down the Delaware River to the bay; and streaks of clayey soil are generally found on one or the other of the banks of the streams

* See Gordon's Gazeteer, p. 1.

running into the Atlantic. With these exceptions the soil is a light sand, and extensive tracts of it are still covered with pines and scrub oaks.

A kind of cemented gravel or pudding-stone, firm enough to be used for the commoner purposes of building, is found in some of the higher hills, and thin layers of limestone, which can be burned into lime, are found in a few places; but solid beds of rock are nowhere met with.

"The whole of the district is tolerably well watered; but the streams are neither large nor rapid, and are remarkable for the depth of their beds, which cause, indeed, almost the only inequalities in its surface." "Most of the streams have crooked courses, and flowing through a flat country, are commonly navigable some miles from their mouths. Unlike the rivers of hilly countries, they are steady in their volumes, and uniform supplies of water can be more confidently relied upon."*

There being but little water power, manufacturing is not carried on to any considerable extent. Deposits of bog iron ore are found, and a small amount of iron is made from them; and there is an abundance of excellent sand for glass making, which, with the cheapness of fuel, has caused the establishment of numerous glass-houses. The principal business of the inhabitants is agriculture. In this, remarkable advances have been made within a few years. In 1834, Gordon says, "An immense forest covers probably four fifths of this district, and forty years ago it was not worth more than from six to ten cents an acre. From this they have risen to an average price of six dollars an acre."

The following statement, compiled mostly from the United States Census of 1850, shows nearly its present condition.

* See Gordon's Gazetteer.

COUNTIES.	FARMS IN ACRES. Improved.	Unimproved.	Average value per acre.
Third of Mercer,	31.793	7,196	$54 13
Half of Middlesex,	57,969	21,053	41 21
Monmouth,	145.739	82.440	50 40
Ocean,	26,466	28,387	19 86
Burlington,	132.017	40,670	67 56
Camden,	53.968	77,416	35 49
Atlantic,	15,006	34,585	13 80
Gloucester,	68,810	52,897	37 37
Salem,	105.956	38,942	45 88
Cumberland,	48.469	71,646	22 10
Cape May,	14,310	37,653	15 87
Total,	700,503	492,885	Mean 41 70

The following table, compiled from the same sources, will furnish data for comparison with the whole State, and also with the neighboring States.

STATES.	Area in acres.	FARMS IN ACRES. Improved.	Unimproved.	Average value of farms per acre.
Massachusetts,	4,640,000	2,133,436	1,222,576	$32 50
Connecticut,	3,040,000	1,768,178	615,701	30 50
New York,	29,440,000	12.408,968	6,710,120	29 00
New Jersey,	4,384.640	1,768,991	984,955	43 67
Pennsylvania,	30,080,000	8,628,619	6,294,728	27 33
Delaware,	1,356,800	580,862	375,282	19 75
Maryland,	7,040,000	2,797,905	1,836,445	18 81

In these tables the improved lands include only such as produced crops; the unimproved, such as did not produce crops, but were connected with the farms. Unoccupied land is not included under either of these heads.

A comparison of the first and second table shows, that while the value of the land in farms is a little less in the southern division than the average of the whole State, it is still greater than that of any other State mentioned, and it is greater than that of any other State in the Union. I have not

been able to ascertain the areas of the counties separately, and cannot give the amount of land in farms, compared with that still unoccupied. But if we suppose one half of the State to be in the southern division, a little more than one half its area must be in farms, which is less than in Massachusetts, Connecticut, New York, and the northern half of New Jersey; and greater than in Pennsylvania, Delaware, and Maryland.

The climate is mild or even warm, and the early springs and light soils enable the farmers to furnish the first supplies of garden produce to the markets of New York and Philadelphia, and a large part of such supplies for those cities is drawn from New Jersey. Of other crops, Indian corn and potatoes are raised in largest quantities. Wheat, rye, oats, and sweet potatoes are extensively cultivated. The amount of live stock is much above the average of our country.

The rapid advance of agriculture in this district is due in part to its location, in part to the improvement of the country generally, but more is to be ascribed to the use of a kind of marl which is found here in immense quantity. The belt or strip of land under which this is found lies obliquely across the State from Sandy Hook Bay southwest to Salem. Its length is about ninety miles, and its breadth fourteen miles at its eastern extremity, and six miles at its western. Its area is nine hundred square miles, or five hundred and seventy-six thousand acres; and its benefits are shared by a considerable district of country lying on each side of it, so that the whole area improved by it is swelled considerably beyond the above amount. It has been worth millions of dollars to the State in the increased value of the land and produce, besides the influence it has exerted in awakening and fostering a spirit for agricultural improvement. Requiring labor and not money from those who would enjoy its benefits, it has been found admirably adapted to encourage and reward enterprising industry.

The attention of men of science has been frequently called to this interesting formation on account of its value in agricul-

ture, and also for its numerous and remarkable fossils; bones, shells, sharks' teeth, &c., being common in it. Its geological character was first distinctly shown by Professor L. Vanuxem, Dr. Morton, and Mr. Conrad, of Philadelphia, in eighteen hundred and twenty-seven. In eighteen hundred and thirty-five, the legislature ordered a geological survey of the State to be made. This was done by Professor H. D. Rogers, and his final report was presented in eighteen hundred and forty. This report included a very full account of the marl, both geological and chemical. Numbers of analyses of the varieties of it have been made by other chemists; some of these are important, and will be referred to again. Under such circumstances, the present examination was entered upon with a good deal of distrust; and nothing but a knowledge that the openings into the marl were much more numerous and extensive than when Professor Rogers closed his survey, and that thus an opportunity for study was now presented which was not then available, could have induced an attempt to re-examine what had already been so well done.

DESCRIPTIVE GEOLOGY.

From examinations in the field, the following facts are proved:—

1. The clays and marls, which constitute the basis of most of this part of the State, are in regular and continuous layers.

2. These layers are not level, but incline or *dip* towards the southeast. They have been observed to descend from twenty to fifty feet in a mile.

3. Since these layers were formed, the action of water, or other causes, has worn away and changed the surface of the country.

In passing across the country from the north towards the south, we come upon the different layers in orderly succession; in examining the pits which have been opened for marl, the successive layers are always found in the same order; exami-

nations upon the sides of hills where they have been cut into, show the same order that is found in the lower grounds to the south of them; and the same fact is observed in the banks of streams which cut through the layers.

From the fossils found in these beds, geologists have determined that the marls and the clays north of them, and between them and the red sandstone, belong to the cretaceous or chalk formation,* and that the beds on the southern border of the marl belong to the tertiary. The sands and some of the clays south of these, are probably of more recent origin.

The general principles stated above, are all exemplified in Eastern Monmouth; the clays are found on its north side, the marls across the centre, and the sands on the southern side.

I. The clays occupy the county between the northwest line of the county and the northern sides of the hills which extend from the Nevisink to Mount Pleasant, and on to near Englishtown. On the shores of Sandy Hook and Raritan Bay, the clay is thickly covered with sand. In the valleys between some of the hills mentioned, it extends considerably further south. It is almost black when wet, but is gray when dry. It contains a good deal of micaceous sand. The trunks and branches of trees, in the form of lignite, are found in it in great quantities, and frequently associated with sulphuret and sulphate of iron. Irregular streaks of green marl are also found in it; in some places enough to make it valuable as a manure. Characteristic fossils are also found. The examinations made thus far have not been sufficient to furnish precise descriptions of the position or qualities of the different layers or even of the beds of this stratum.

II. The marls are found in various parts of the country from the south line of the clays to a line drawn from the At-

* A "formation," in geology, is "that collection or assemblage of beds or layers, strata or portions of earth or minerals, which seem to have been formed at the same epoch, and to have the same general characters of composition and lodgement." (Webster.) In this report I will use the terms stratum, bed, and layer, for the successive subdivisions; thus dividing the formation into "strata," each stratum into "beds," and each bed into "layers."

lantic shore, near Great Pond, in Deal, to the Manasquan River, between Upper and Lower Squankum.

The substance here called marl, is not the ordinary calcareous clay or earth, which is distinguished by its light color and its effervescence with acids, but is a kind of earth, most of which is in little rounded grains, about the size of fine gunpowder; its color is usually some shade of green; the crushed grains are always green; and they are so soft that they can easily be crushed on the nail; they scarcely effervesce with acids. Besides the grains in the marl, there is generally a little white sand and some clay; the latter being of various shades of black, brown, drab, or green, and so mixed in as to give color to the whole; great numbers of shells are found in some of the layers; these of course cause the marl to effervesce. The marl grains are known in geology as *greensand.*

Though the whole series of beds which is exposed in the district now under examination, is called the *marl stratum*, yet marl grains are not found in all the beds, some of them consisting entirely of sand, and others of clay.

There are three distinct beds of marl in the stratum: the *first* includes those found north of the north branch of Shrewsbury River, Swimming River, and Yellow Brook; also those found on the head waters of South River, north of Freehold. A few pits have also been opened below tide level at Red Bank. The *second* includes those near the head of the south branch of Shrewsbury River; those near Eatontown; those along the valley of Hockhockson Brook, above Tinton Falls; those a little south of Colt's Neck Village; those about a mile and a half south of Freehold, and those south of Blue Ball; it also includes the yellow marls south of Eatontown and about Long Branch; the same bed is also found near the tops of the hills south of Red Bank and that south of the Phalanx Dwellings, and I think in some of the highest points of the Nevisink Hills. The *third* bed includes the marls of Deal, Poplar, Shark River, and Squankum.

The bed of yellow ferruginous sand which is so conspicuous a feature in the soil of the Nevisinks, at Red Bank, at

Colt's Neck, and indeed entirely across the State, lies between the first and second beds of marl.

A bed much resembling beach sand, with a very few marl grains scattered through it, lies between the second and third marl beds.

The several beds of marl are each made up of distinct layers, which vary in appearance and in properties.

In the first bed five distinct layers may be recognised.

1. A layer of sand and fine gravel, from two to four or more feet in thickness. This is very distinctly separated from the clay which lies immediately under it. It contains numerous fossils, a considerable proportion of marl grains, and is valuable as a manure. It is known as *sand marl.*

2. A layer of nearly pure marl grains, of variable thickness, averaging perhaps four feet. A little blackish clay is mixed with the marl, from which it is generally known as *black marl.* It contains but few fossils. As a manure it is highly prized. Though always found, it is not very distinctly separated from the next layer.

3. A layer of from twelve to sixteen feet in thickness, known as *blue* or *gray* marl, from its containing a considerable amount of a drab colored clay, inclining to bluish or grayish. It has numbers of very large and heavy oyster shells in it—generally there is a streak from eight inches to two feet thick, which is almost solid with shells. This layer is very highly prized as a quick and lasting fertilizer. It changes gradually into the one next above.

4. Three or four feet of *black marl*, almost exactly like that of No. 2. It is not found distinctly marked in all places.

5. Dark colored marl six or eight feet thick, containing fewer and fewer of the marl grains in its higher parts, and at last only to be distinguished from the dark clay into which it runs, by the thin flaky shells scattered through it.

The thickness of this bed of marl is at least thirty feet. The whole can be seen in the side of the Nevisink Hills on the shore of Sandy Hook Bay. They have all been passed through in the pits of the North American Phalanx, and Mr.

William Hartshorne had them bored through for me in his pits, north of Freehold. All except the top layer is well exposed in the pits of Wm. Conover, near Marlboro'. And they can be seen in succession, by passing along the valleys of any of the streams which run through the marl, as the Spottswood north and south branches of South River, and in the Hop Brook from Taylor's Mill to Marlboro'.

The following circumstances may produce a little difficulty, at first, in verifying the preceding statements. Whenever the clay, which lies immediately over this bed of marl, has been worn away, and the marl lies above the bed of neighboring streams, the rains and surface water penetrate it, to a greater or less depth, and leach off; dissolving out the fossils and leaving earth in their places; changing its color to a rusty red; and forming numerous flaky crusts, or sometimes strong cakes of impure oxide of iron, in it. Such marls are called *dry bank* or *hill* marls. These changes have taken place to a much greater extent in some localities than in others. Marls which lie so as not to be subject to the action of surface water, or drainage, are called *wet bank* or *meadow* marls.

The characteristic fossils of this bed are Exogyra costata, Gryphaea convexa, Ostrea falcata, Terebratula sayii and Belemnites americanus. A great many others are found, but they are not so numerous and not so generally present in all localities.

Lying immediately upon the bed of marl which has just been described, and not separated from it by any well marked division, is a layer of black clay. It contains scales of mica and grains of sand. In small quantities it cannot easily be distinguished from the clay of the stratum below the marl. It frequently contains sulphate of iron (copperas); and being often mistaken for marl has been used to the injury of the farmer. When composted with quicklime it is thought to be useful. It is from ten to twenty feet thick.

The red or ferruginous sand lies upon the clay just mentioned. It is separated from it by a well marked line of division. This bed is of great thickness; not less than one

hundred feet at Red Bank, and in the Nevisinks it is equally thick. Whenever this sand has any degree of firmness it is full of the impressions and casts of shells and other fossils. The lower part of this bed is a very friable sand; towards its upper part a greenish clay is found mixed with the sand, giving to it a good degree of firmness; the rock at Tinton Falls is an example of this. The upper part of this bed, from four to six feet, is a layer of greenish indurated clay, in some places hard enough to be called a rock. It slakes on exposure to the weather. No marl grains are found in it; but it is called marl by many farmers, and is profitably used as such.

The *second bed* of marl is not so extensively developed in this part of the country as the first one; though it is considerably thicker. Its several layers may be described as follows:—

1. A layer of marl containing but very few fossils; its lower part almost clean grains; clay is mixed with the grains in the upper part, in many localities. The color of the grains in this layer, and indeed in the whole bed, is green with a shade of yellow, unlike those in the first bed, in which the color is green, with a shade of black or dark blue. I have not in any place in this part of the county found the layer worked more than fourteen feet, though I believe it to be much thicker. In the pits of Mr. Imlay, on Crosswicks Creek, a short distance below New Egypt, it is nearly twenty-five feet.

2. A layer of from ten to fourteen feet of marl, with numerous shells. A streak in the upper part of this, for two or three feet, is almost solid with shells of the Terebratula harlani; and another layer near the bottom of it is equally solid with shells of the Gryphaea convexa. This layer gradually loses its marl grains, at the upper part, and runs into

3. A layer of broken shells with more or less sand intermixed, and containing scarcely any marl grains. The color of this marl is *yellow* or *gray*. In the neighborhood of Eatontown it is called *yellow marl*. No localities have been visited in Eastern Monmouth where it has been penetrated more than fourteen feet, but near Salem it has been opened for more than twenty feet.

There are no good localities where all these layers are to be seen together. The nearest approach to it is in the pits of Mr. Strickland, near Blue Ball, where the top of the first, the whole of the second, and the bottom of the third layers are shown. The meeting of this bed and the clay of the sand bed under it is well shown in the marl pits of J. S. Trafford, Daniel Polhemus, and John S. Cooke, above Tinton Falls. Also in the pits of Mr. Lafetra and Mr. Lippincott, on the north side of Parker's Creek, near Eatontown. The *yellow marl* is dug near the Turtle Mill at Long Branch. Also by Dr. Lewis and others, of Eatontown. The bottom of Edward Wolcott's marl, near the latter place, cannot be distinguished from the top of Strickland's.

A large number of species of fossils are found in these different layers. Those mentioned under (2) are the most common and characteristic. The Gryphaea convexa of this bed is much smaller and thinner than that found in the first.

The bed of sand between the second and third beds of marl has nothing remarkable about it, except the grains of marl scattered through it. Its meeting with the top of the second bed is not known to have been found. It can be seen under the third bed in the pit of Elisha West, of Deal, that of Rulief Vandeveer, of Poplar, that of Thomas Longstreet, of Squankum, and it is said under that of John Shafto, of Shark River. The bed itself has been opened near Elisha West's, in Deal, and the sand used as a fertilizer on account of the marl grains in it. It bears a striking resemblance to the beach sand of the neighborhood which has also been used for the same purpose. No opportunity has occurred for measuring the thickness of this bed, but from the inclination of the beds above and below, it may be estimated at not less than thirty feet.

The *third bed* of marl may be described as consisting of three layers, as follows:—

1. Twenty feet of green marl. This contains a considerable percentage of greenish clay: it is distinguished as a quick and powerful fertilizer; the most noted marls of Squankum, Shark River, Poplar, and Deal are from this layer.

2. Fifteen or twenty feet of a pale greenish clay or earth. No marl grains are found in this layer, though it is called marl and possesses active properties as a manure. It is flaky in its structure, and when exposed to the air fades to a light ash color.

3. From five to fifteen feet of the above clay, largely mixed with marl grains.

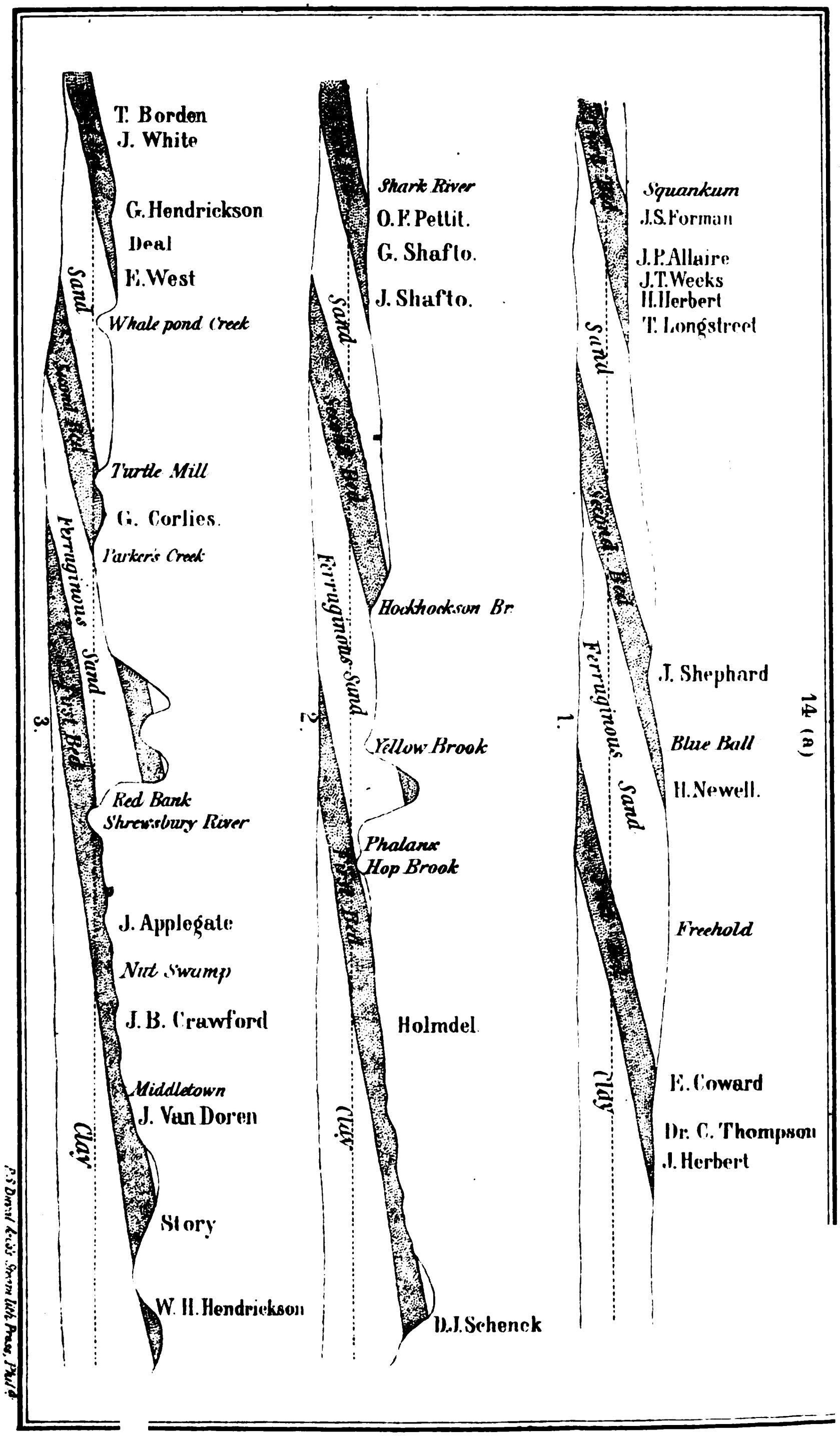
The last named layer is opened to the greatest thickness in the pits of Jacob White, Peter Drummond and Amos White, in Deal; in that of O. F. Pettit, Shark River, and in that of J. S. Forman, near Lower Squankum, it is not so thick. In all these it can be seen running into the layer next below.

There are no localities where all these layers can be seen in a single place, but they can be seen in succession in numbers of places, as in the pits of Elisha West, G. Hendrickson and Thomas Borden, of Deal; in those of J. Shafto, H. Hurley, G. Shafto, and J. L. Tilton, of Shark River, and in those of T. Longstreet, T. Weeks, and J. S. Forman, of Squankum.

Fossils are not very abundant in this bed. A few casts, and still more rarely shells, have been found in the lower layer; it is not known that any have been found in the middle layer; in the upper, casts and impressions of shells are found. They have not been examined with sufficient care to determine the species; they are, however, entirely different from those of the two lower beds.

The accompanying sections across the marl stratum, show the positions of the several beds. The scale of distances is two miles to one inch. The scale of heights about 400 feet to an inch: the heights, however, have not been accurately measured. These sections are taken at right angles to the stratum.

In addition to showing the positions of the several beds, they also exhibit the effects of peculiar configurations of surface on the extent of the marl bed exposed: thus though the same beds are shown in each of the three sections, the amount of marl at the surface appears to be quite different in the same bed as seen in the different sectional views. The first bed ap-


14 (a)
3.
T. Borden
J. White
G. Hendrickson
Deal
E. West
Whale pond Creek
Turtle Mill
G. Corlies.
Parker's Creek
Red Bank
Shrewsbury River
J. Applegate
Nut Swamp
J. B. Crawford
Middletown
J. Van Doren
Story
W. H. Hendrickson
Sand
Ferruginous Sand
Clay
2.
Shark River
O. F. Pettit.
G. Shafto.
J. Shafto.
Hockhockson Br.
Yellow Brook
Phalanx
Hop Brook
Holmdel.
D. J. Schenck
Sand
Ferruginous Sand
Clay
1.
Squankum
J. S. Forman
J. P. Allaire
J. T. Weeks
H. Herbert
T. Longstreet
J. Shephard
Blue Ball
H. Newell.
Freehold
E. Coward
Dr. C. Thompson
J. Herbert
Sand
Ferruginous Sand
Clay
P. S. Duval & Co's Steam lith Press, Phila.

pears three or four times as extensive in the second and third sections as in the first.

III. The sands which form a strip along the southern border of this county join the marls in a very irregular line, ridges of them extending up almost to the middle of the county, while in the valleys of the streams, the marl comes to the surface several miles further south. They have not yet been examined with sufficient care to render it necessary to make any report upon them.

The interest felt in the marl stratum by a very large portion of the inhabitants of Monmouth, has induced me to devote most of the time, thus far, to ascertaining and systematizing facts relating to it. The examinations of the clay stratum and of the sands promise to be of much practical utility, though the soils where they occur have not yet been brought to the high state of cultivation of the marl region, and they are generally thought of less value.

The regular order of occurrence of the different beds of marl in the district surveyed led to a desire to examine their relative position in the southwestern part of the State. For this purpose the stratum was crossed from Allentown to New Egypt, and again in the vicinity of Salem, and the same order of succession of beds was found.

The marl pits of N. Woodward, at Cream Ridge, belong to the first bed. The ridge itself is part of the ferruginous sand bed. The pits at Hornerstown, and those of Mr. Imlay and Mr. Horner, near New Egypt, are in the second bed; so also are the gray marls, such as those in Governor Fort's pit. The pits of Mr. Irons, south of New Egypt, and others from there on to Poke Hill, in Burlington County, belong to the lowest layer of the third bed. The upper layers have not been found in that vicinity.

The marls in Salem County, at Mannington Hill and at Woodstown, belong to the second bed. At Batten's Mill, above Swedesboro', the first marl bed is seen. The ferruginous sand lies between the two. The third bed has not, to my

knowledge, been found in Salem County. The marl at Mullica Hill belongs to the second bed. William H. Snowden, of that village, showed me a collection of tertiary shells from a locality about two miles south or southeast from there, and among these were some casts of shells of the same species with those found in the lower layer of the third bed. I hear that he has since found the bed containing those characteristic fossils.

From the report of Professor J. C. Booth on the Geology of Delaware, it appears that at least two of these beds are found in that State. The stratum is known to extend into the States farther south.

The hasty examination given to the different beds west of Freehold, does not enable me to decide whether they retain the same thickness, or whether the first and third beds grow thinner towards the southwest. They are not as well exposed or as extensively worked; the greater portion of all that is used, being taken from the second bed. Other causes than the thickness, however, affect the amount of their exposure. For example, the increased breadth of the marl stratum on the eastern side of the State is partly due to its northern border being on elevated ground and its dip towards the southeast only a little more than the slope of the country in that direction; while on the western side of the State, the stratum is diminished in width from its northern border being on low ground and its dip to the southeast, contrary to the surface of the country, which rises in that direction. The several beds are much better exposed in a rolling country than in one that is even or flat; thus, in the district surveyed, the first bed, though thinner than either of the others, is by far more exposed than both of them together. The country in which it occurs is uneven and hilly; the marl may then be found either in the valleys or the side hills, and these are so common that almost every farm has a marl pit on it, and in some a pit is opened in every field. The country is much more even and level where the second and third beds are found, the valleys of the streams making almost the only inequalities of the surface,

and it is in these principally that the marls are dug. The practice in this respect is so uniform that many persons suppose they are only to be found in the valleys of streams. A knowledge of the fact that the beds are to be found on high as well as on low ground, that they continue nearly uniform in quality and thickness in straight lines across the State, and that they descend towards the southeast with a very regular slope, will, it is hoped, lead to a more general opening of pits in neighborhoods where marl is not now known to exist. Marls have been carted long distances, and deposited on lands which were underlaid by marl, and such, from my own observation, I am satisfied is still being done in many places. In addition to the advantages to the farmer from having an abundant supply of marl close at hand, the value of good marl pits should be taken into the account. Pits ten feet square, and as deep as the purchaser chooses to dig them, are sold for from five to seven dollars. An acre contains forty-three thousand five hundred and sixty square feet, or more than four hundred and thirty-five such pits, worth, at the lower price, two thousand one hundred and seventy-five dollars, and at the higher price, three thousand and forty-five dollars. Such lands are worth searching for, and, if the work is judiciously done, they will be found. The following directions may aid in making examinations.*

Knowing that the general direction of the beds is a little west of southwest, a line traced in that direction from any pit already opened, will continue on the same bed. Or a line run between two pits of the same bed, will continue on the same throughout. Searches by digging down or by boring may be

* Borings for marl can be easily made with a common auger; an inch and a half one is large enough. Its shank may be lengthened as much as is required by welding on a rod. The handle should be made to slide on this rod, and fasten with a set-screw or wedge. The auger needs raising every few inches to clear it, and to examine the material penetrated, some of which will be found sticking in the twist of the instrument. With such an auger, a hole from ten to twenty feet deep can be made in a few minutes.

made anywhere on such lines; the lowest ground will usually have the least thickness of soil or *top dirt.* If this dirt is found too thick for profitable working, other places may be tried, for the marl is worn or gullied in its upper surface sometimes, and the best points for opening may not be hit at the first trial. If the lines are run over uneven ground, allowance must be made for the dip or descent of the beds, which is towards the southeast, and at the rate of from twenty to fifty feet a mile. This dip will cause beds to appear further to the northwest if the ground is higher, and to the southeast if it is lower than that started from.

COMPOSITION OF THE MARL, AND THE CAUSE OF ITS FERTILIZING ACTION.

The value of this deposit as a manure, and the surprising influence it has upon the agriculture of a large district of country, have drawn the attention of scientific farmers and chemists to its composition.

Mr. Seybert, of Philadelphia, made a careful analysis of this marl, which was published in 1822, in the second edition of Cleaveland's Mineralogy. He found ten per cent. of potash in it.

James Pierce, Esq., examined the marl beds of New Jersey, and published an interesting account of them in Silliman's Journal, Volume VI., page 237, in 1823. He attributes the virtue of marl principally to its shells and other calcareous ingredients.

Dr. R. Harlan, in a paper containing remarks on the Geology of West Jersey, in Volume IV., page 15, of the Transactions of the Academy of Natural Sciences of Philadelphia, in 1824, attributed its value in some cases to its fossil shells, in others to the iron pyrites in it, and in still others to the clay which it contained.

A paper on the same subject, Volume VI., page 59, Trans-

actions of the same Society, in 1828, by Professor Lardner Vanuxem, says, "the marl of New Jersey and Delaware appears to owe its fertilizing property to a small quantity of iron pyrites (which passes to sulphate of iron by exposure to the air), and also to animal matter, to its color, and to its effect when mixed with sand, of diminishing the calorific conducting power of the latter."

Prof. Rogers, in his Geological Report of New Jersey, considers that there is abundant evidence "to prove that the true fertilizing principle in marl is *not lime* but *potash*."

Prof. J. F. W. Johnston, in his Notes on North America, made in 1850, Volume II., page 308, says, that on analyzing some of the green grains and sand, he found "from one to one and a half per cent. of phosphate of lime," and to this he attributes its fertilizing power.

In the Working Farmer for April 1, 1853, are several analyses of marl by Dr. Charles Enderlin, of New York. His specimens were from the pits of the North American Phalanx. He found two and a half per cent. of phosphate of lime in one specimen. He also found that the alkali was not all potash, but part soda. The fact of soda being a constituent of the marl was published in Silliman's Journal, second series, Volume IX., page 83, for 1850, from an analysis by William Fisher.

Numerous other references might be given, but the above are enough to show that the question is still an interesting one.

The following analyses show the principal constituents. Sulphates of iron, lime and alumina, phosphates of iron and lime, chloride of sodium, organic matter, &c., which can be detected in it in small quantities, will not materially affect the proportions of the principal substances.

The first (1) is the analysis made by Mr. Seybert, the second (2) is the average given by Professor Rogers, and the third (3) is the analysis made by Mr. Fisher.

	(1)	(2)	(3)
Silex, ...	49.83	48.50	53.26
Alumina, . .	6.00	7.30	3.85
Protoxid of iron, .	21.53	22.80	24.15
Potash, . .	10.12	11.50	5.36
Soda, . . .			1.60
Lime, . .		.50 or less.	1.73
Magnesia, . . .	1.83	trace.	1.10
Water, . .	9.80	7.90	10.12
Loss, . . .	.89		
	100.00	99.50	101.17

The preceding statements and analytical results show that the subject is by no means a plain one. To me it is one of deep interest, and I have taken every pains to inform myself upon the practical agriculture of the district, and the influence which marl has exerted in bringing it to its present high condition. With this knowledge my chemical examinations have been conducted, but they are not yet in such a state of forwardness as to be presented complete. A few approximate results will be given.

In the following table the amounts of phosphoric acid and lime are given, in the first and second columns. They are averages from several analyses of specimens from different pits. The third and fourth columns give the amount of phosphate and carbonate of lime. The phosphate is calculated from the phosphoric acid, and it probably exists in the marl in this form. The only doubt of it arises from the fact that phosphate of iron is a common mineral in this stratum. Careful examinations have not been made to determine the amounts of potash and soda; enough, however, has been done to show that they are always present, and constituting from five to ten per cent. of the whole.

Percentage of Phosphoric Acid, Lime, Phosphate of Lime, and Carbonate of Lime, in marls from the different layers.

BED.	LAYER.	Phos. Acid.	Lime.	Phos. Lime.	Carb. Lime.
1.	1. Sand marl,	0.76	1.00	1.55	0.37
	2. Black marl,	0.63	1.50	1.29	1.50
	3. Blue or gray marl,	1.14	8.50	2.33	13.04
	4. Top marl,	0.00	7.23	0.00	12.91
Fer. Sand	Green clay,	1.20	1.65	2.25	0.71
2.	1. Grain marl,	0.76	0.90	1.55	0.19
	2. Green marl and shells,		10.20		18.21
	3. Shells, yellow marl,	0.00	27.44	0.00	49.00
3.	1. Green marl,	2.80	2.40	5.71	0.00
	2. White marl,	0.78	1.50	1.59	1.23
	3. Blue marl,	1.04	1.70	2.13	1.09
	Dry-Bank marl.	1.14	0.30		0.00
	" "	1.39	0.50		0.00

The results presented agree, generally, with the experience of farmers. The marl containing the largest amount of phosphate of lime, is the first layer of the third bed; the green marl of Squankum, Deal, Shark River and Poplar. It is noted for quick and powerful action when applied in light dressings; from five to twenty loads on an acre produce good effects, and it is sometimes used in even smaller quantities. No. 3 of the first bed is well known as an excellent marl. From one hundred to two hundred loads are commonly applied to an acre, and such dressings last fifteen or twenty years. It will be observed that this layer contains less phosphate, but much more carbonate of lime than the one just mentioned; and probably this is the cause of its more permanent action. The first layer of the second bed seems, from the analysis, to be much better than practice has found it. The difference may be owing to the coarseness and cleanness of its grains, for when mixed with quicklime and applied to the soil, it produces ex-

cellent effects. The dry-bank marls, it will be observed, are deficient in lime; phosphoric acid is found in them in the usual amount. These specimens were from the first bed, and probably the third layer. They have usually been thought equal to the wet-bank marls of the same bed, for a short time, but to wear out sooner. Other comparisons will suggest themselves to the minds of inquiring farmers.

"POISON" OR "BURNING" MARLS.

Marls are found in all parts of the stratum, which are said to be *burning* or *poison* in their properties; so much so as to destroy vegetation. In some cases where they have been freely applied to the soil, they have destroyed its fertility for years. These marls are not confined to any particular layer or bed, but are found in spots or patches in all of them. The dark clays above and below the first marl bed also possess the same properties, and being frequently mistaken for genuine marls, have done serious injury to crops upon which they have been applied. The same is true of the brownish clay, called *rotten stone*, which is found on top of any of the layers of the third bed. In all these cases the injurious effect is due to sulphate of iron (*copperas*), or to that substance mixed with sulphate of alumina (a kind of *alum*). The latter substance is not near as common as the former. Either of them can be easily distinguished by the taste; the copperas is well known by its astringent, inky taste; the other by the taste of alum. When marls, or earths containing them, are exposed to the air, yellowish white incrustations of these salts form on their surfaces. If other tests are desired, take some of the marl and boil it in two or three times its weight of water, in a clean earthen or porcelain dish; then strain the water clear from the marl. The copperas and alum will be in solution in the water. If some of this water is poured into strong tea, it will turn it black; if poured into lime water it turns it a dirty white; and if added to the blue liquid made by pouring hot water on

leaves of red cabbage, the color is changed to a red. If aqua ammonia (*hartshorn*) is poured into it, there is a reddish or greenish sediment formed.

Professor Rogers, in his report, recommended that such marls be exposed to the weather some time before using, that the copperas and alum might leach out. As a still better method, he recommended composting them with quicklime, using perhaps a bushel of lime to a hundred bushels of marl. Wherever this remedy has been tried it has been found effectual, and upon soils which have been injured by the application of such marls it has restored their fertility. It is not so generally practised as it ought to be, most farmers thinking it cheaper to get marl from beds not contaminated with these substances. The action of the lime upon the copperas produces *plaster*, but this is already in the marl, as is shown by its forming a white crust or powder on the surface of marls which are exposed to the open air, as well as by the sparkling little crystals of it which may be seen in many cases. Plaster is not generally found to produce any effect upon soils which are well marled. Still the use of lime with those marls cannot be too strongly recommended, the very fact that copperas and alum are present proving a want of lime, and whenever there is a sufficient amount of quicklime, or of carbonate of lime, in a marl, these substances cannot exist. The use of lime too may give activity to marls, which by themselves are almost valueless, causing the grains to crumble and give up their fertilizing constituents to the growing crops.

Wells which are sunk in the marls frequently contain so much of the copperas and alum in their waters, as to be unfit for making tea or coffee, turning the tea black. A little saleratus or pearlash, or even woodashes, boiled in the tea-kettle with the water, corrects this.

As directed, specimens have been taken from all the layers which have been examined, and from those of the marl, great numbers from different pits in the same bed. The collection of fossils is not as complete as is desirable—such an one requiring more time than it has been possible to devote to it.

A large number has been collected, however, and for many more the survey is indebted to the generosity of friends. Valuable and interesting specimens of fossil bones, teeth, shells, &c., have been received from Capt. T. Weeks of Squankum, Mr. W. Lippincott of Shrewsbury, Mr. J. S. Cooke and Mr. Polhemus of Tinton Falls, Mr. C. T. Matthews of Colt's Neck, Mr. Azariah Conover of Middletown, Rev. Mr. Riley and Mr. H. G. Cooke of Holmdel, and Mr. W. Hartshorne of Freehold. Some remarkably fine specimens of crystallized phosphate of iron were presented by Mr. P. Lafetra of Shrewsbury. The greatest liberality has been shown in regard to specimens, and the collection by donation would have been much larger, had care been previously taken to preserve them. It is hoped that the donations will be much greater the coming season, when it becomes known that as large a collection as possible is desirable to illustrate the geology of the State. Important service can, in this respect, be rendered to the survey.

In studying out the position and peculiarities of the various beds of marl, great assistance has been received from gentlemen residing in the county. All have willingly furnished any information required. Especial notice is due to Mr. W. H. Hendrickson and Mr. G. C. Murray of Middletown, Rev. G. C. Schenck of Marlboro', Mr. C. Sears of the Phalanx, Mr. J. S. Cooke of Tinton Falls, Rev. Mr. Finch of Shrewsbury, and Mr. W. Hartshorne of Freehold. Also, to Hon. W. W. Newell of Allentown, and Ex-Governor Fort and Mr. Thomas B. Jobs of New Egypt, Ocean County, and to Messrs. David and J. J. Pettit of Mannington, and Dr. D. M. Davis of Woodstown, Salem County.

GEORGE H. COOK.

REPORT

OF HENRY WURTZ, CHEMIST AND MINERALOGIST.

New Jersey State Laboratory,
Trenton, January 1st, 1855.

To Dr. William Kitchell, State Geologist:

Sir:—On entering upon the duties of my appointment on the first day of November last, my first care was to select a suitable place for a laboratory, in which to perform the analytical and other work required of me by my instructions. Such a place having been procured, it was necessary to devote more than half of the very limited time set apart for the work of this season to the furnishing and fitting up of such laboratory, procuring the requisite apparatus, and preparing the reagents and other materials required, in that state of perfect purity necessary to the performance of reliable analyses; so that when I found myself prepared to commence work, from three to four weeks only of the specified period remained, a time altogether too short for the performance of any extended chemical investigation.

Operations were commenced, however, all at once, upon *six* of the specimens collected by you, comprising four varieties of calcareous marls and two of calcareous sinters, and although it has been found impossible to bring these analyses quite to a final close, yet by dint of constant application, an amount of labor has been accomplished which could scarcely have been expected, not less than fifty-five quantitative deter-

minations having been made, besides the large amount of qualitative investigation necessary; and the results already obtained possess several wholly unexpected and important points of interest, which hold out high promise of the value of more extended and thorough explorations and investigations of these abundant calciferous deposits.

My results, thus far obtained, are as follows:

I. A.

Marl, taken from the surface of a deposit found upon the estate of Isaac Bonnell, in Montague Township, Sussex County.

It presents the appearance of a light gray pulverulent mass, principally made up of the *debris* of small fresh-water shells, and is mixed with radicles of grass or other roots, and a few small black specks of peaty matter. When heated upon a sheet of platinum, it blackens, smokes with a peaty odor, and burns easily to a nearly white ash, which exhibits a curious kind of repulsion for the platinum while hot, passing into a sort of spheroidal state, and floating in the air, remaining in this condition for a long time, certainly after the expulsion of all volatile matter, and at a temperature too low to cause evolution of carbonic acid, thus indicating the development of a true repulsive force. After cooling, it is found caked together into a compact mass. These phenomena seem to me to be pyroelectric. When heated in a close tube, gives off a considerable quantity of water, which is strongly ammoniacal, together with a tobacco-like odor (indicating the presence of ammonia-crenate of lime).* This ordor is very strong and persistent, filling the whole laboratory with a smell precisely resembling that of an old foul tobacco pipe. At a stronger heat a quantity of tarry matter distilled over. Water boiled for a long time with the marl acquires a faintly yellowish tint, and

* Berzelius, as quoted in Loewig's "Chemie der organization Verbindungen," I. 485.

an odor strongly resembling that of a grist-mill, remaining perfectly neutral in its reaction, and becoming at the same time exceedingly difficult to filter clear. Solutions of the marl in acids possess a light amber color, and little or no smell.

The ingredients of this marl,* with the percentage proportions thus far determined, are—

* Some brief remarks upon the methods used in these analyses will be in place here, although when the analyses shall hereafter be presented in a complete form, minute descriptions of the methods will be given.

The phosphoric acid was detected by the molybdate of ammonia reaction, and the same reaction used, according to the suggestion of Sonnenschein, in its quantitative determination, that is, by precipitating it with molybdate of ammonia, redissolving the washed precipitate in ammonia, precipitating with sulphate of magnesia, and weighing as bibasic phosphate of magnesia. This process seems to present more of the elements of reliability, for determining phosphoric acid when present in small quantities, than any other yet proposed, but it was nevertheless found that the considerable solubility of the yellow molybdic precipitate in the wash-water has a greater influence than has been supposed, and that the determinations made are therefore probably too low. Observations were made, however, which induce the hope of so modifying the method of Sonnenschein, as to eliminate this source of errror, and thus render it as accurate as it is convenient.

Manganese, when present, was detected by Crum's test, with nitric acid and deutoxide of lead, the delicacy and certainty of which cannot be too highly appreciated.

The carbonic acid was determined by means of a small apparatus similar to that described in Rose's Handbuch, last edition, Volume II., page 801.

The amorphous silica by boiling the substance with pure caustic soda solution for a long time in a platinum vessel, evaporating the filtered solution with an excess of chlorohydric acid, collecting the separated silica on a filter, washing, drying, burning, and weighing.

The portion of the marls insoluble in chlorohydric acid was dried upon a weighed filter at 100 deg. C., weighed, and afterwards burnt, and weighed again, the difference between the two weights being, of course, the insoluble organic substances present. The organic acids soluble in chlorohydric acid were determined together with the combined water, by the loss, except in the case of analyses II. B., in which the whole amount of water and organic matter was determined by burning a weighed portion of the marl as perfectly as possible, then restoring the lost carbonic acid by evaporating with carbonate of ammonia, drying and weighing, the difference being, of course, the whole percentage of volatile and combustible ingredients, from which, by deducting the organic matter in the insoluble portion determined as before, was obtained the sum of the organic matter in the soluble portion and the combined water.

The hygroscopic water was determined by drying at 100 deg. C., until the weight was constant.

1. Ingredients soluble in water.

Chloride of calcium, considerable.

Chloride of sodium, } traces.
Chloride of magnesium,

Organic salts of lime, such as ammonia-crenate, ammonia-apocrenate, and ammonia-humate, } considerable.

2. Ingredients soluble in chlorohydric acid.		
Lime,	50.27	Corresponding to Carbonate of Lime, 89.76.
Magnesia,	0.62	Corresponding to Carbonate of Magnesia, 1.30.
Carbonic acid,	38.57	
Combined water, Organic acids, } by loss.	4.10	
Sesquioxide of iron, with traces of alumina,	0.45	
Phosphate of lime,	0.30	
3. Ingredients insoluble in chlorohydric acid.		
Amorphous silica, mean of two determinations,	0.43	
Organic substances, including humic acid, vegetable fibre, etc.,	4.19	
Hygroscopic water,	1.87	
Nitrogen, undetermined.		
	100.00	

I. B.

Marl from the same locality, but taken from *ten feet below* the surface of the deposit.

Some of the determinations given will be repeated before the completion of he investigation.

It may be well to state that all filters used by me, both in qualitative and quantitative operations, have been previously washed with chlorohydric acid and water until perfectly pure. The Swedish paper used in this investigation eft after such treatment, in a filter of ordinary size, no appreciable ash. I will also state that the re-agents used by me, are nearly every one prepared by my own hands, in a state of perfect purity, and many according to improved methods not yet given to the world.

H. W.

Resembles I. A. in its appearance, and in its behavior under the influence of heat in a close tube, and on platinum, except that it does not assume the spheroidal state, nor become caked together on cooling. Water boiled upon the marls acquires the same color and odor as from I. A., and becomes neither acid nor alkaline in its reaction. Solutions of the marl in dilute acids possess a dark amber color, and a strong smell of *formic acid*, indicating the presence of the imperfectly known products of the decay of vegetable tissue called ulmine, ulmic acid, etc. Heating with a little excess of nitric acid partly discharges the color.

The ingredients of this variety are:—

1. Soluble in water.

Sulphate of lime, considerable.
Ammonia-humate of lime, Chloride of calcium, Chloride of magnesium, Chloride of sodium, } traces.

2. Soluble in chlorohydric acid.

Lime,	50.38	Equivalent to carbonate of lime, 89.97 p. c.
Magnesia, with a trace of oxide of manganese,	0.36	Equivalent to carbonate of magnesia, 0.76 p. c.
Carbonic acid,	38.90	
Combined water, Organic acids, } by loss.	4.34	
Sesquioxide of iron, with trace of alumina,	0.16	
Phosphate of lime,	0.66	
3. Insoluble in chlorohydric acid.		
Amorphous silica,	0.37	
Organic substances, including humic acid, decayed vegetable fibre, etc.,	3.54	
Hygroscopic water,	1.29	
Nitrogen, undetermined.		
	100.00	

On examination and comparison of the results of these two analyses, several considerations present themselves. In the first place, the presence of soluble salts of lime is an unexpected result. It is unfortunate that time has not yet allowed determinations to be made of the quantities of these soluble salts which are present, but their presence at all in appreciable quantity is of much practical importance. It is in the form of soluble salts only, that lime can act directly as an aliment of plants, that is, in this form only can it be taken up by their rootlets. Farther investigation will probably indicate practicable means of increasing the production of these soluble salts, and of thus greatly augmenting the value of such marls as fertilizers.

Lime, however, is not the only ingredient of importance indicated by the analyses. Nearly every other substance found to be present has more or less influence. The magnesia, oxide of iron, phosphate of lime, and amorphous silica are all absolutely necessary constituents of all fertile soils, while the organic acids, and other products of vegetable decay, which appear to be present in quite important quantity (six or seven per cent.), also contribute indirectly their influence. The organic acids, especially, undoubtedly act by forming compounds with lime, and other bases present, which are soluble in the liquids of the soil, thus necessitating their introduction into the circulation of plants by the endosmotic absorption of the roots; and if the now mooted question, which will probably receive some discussion in future reports, whether the nitrogen of vegetable tissues be derived from ammonia or not, admits of an affirmative decision, the organic acids must also act indirectly, though powerfully, by retaining the ammonia produced during the decay of the animal matter of the shells, in a highly soluble form, and also by absorbing atmospheric ammonia, or even, as indicated by Mulder,* through the development of ammonia by the combination of the nitrogen of the air with the hydrogen produced by their own decomposition. It will be

* As quoted in Loewig's "Chemie der Organischen Verbindungen," i., 474.

observed that the analyses indicate the presence of ammonia, derived undoubtedly from the decay of animal tissues, the proportions of which, however, have not yet been determined, both from deficiency of time and want of the necessary appliances.

The *amorphous silica*, whose presence is shown by the analyses, merits a few words of comment. It is the ingredient in soils which furnishes to many plants, especially to the cereals, such as corn, wheat, etc., the *silica*, which is absolutely necessary to the formation of their stalk or stem. Silica, which is the most abundant of all mineral substances, forming certainly more than one half of the mass of the earth, so far as the latter is known, occurs in soils in three different forms; first, in the crystalline form, as quartz, sand, etc., in which form it is wholly insoluble, and may be considered inert, so far as the nutrition of plants is concerned; secondly, in combination, in fragments of feldspar, hornblende, and other silicates, in which it is also comparatively inactive; and thirdly, as amorphous or *soluble* silica, or *opal*, as it is called by mineralogists, the only form of much importance in agriculture, since in this form it is soluble in the liquids of the soil. Far too little attention has been paid in analyses of soils and fertilizing minerals to their content of opal or soluble silica, whereas a soil may be rich in every other necessary ingredient, and yet, if deficient in this respect, be perfectly sterile for many crops; a remark which may indeed be made with reference to each and every one of the soil-constituents which are required to the building up of vegetable structures; these substances bearing precisely the same relation to the plant as the mineral ingredients of the bones do to the animal, or as the constituents of the shells do to the egg, being consequently just as absolutely indispensable in the one case as in the other.

This subject of the alimentation of plants will of course be repeatedly resumed in future reports, based, it is hoped, upon far more extended investigations of fertilizing materials, as well as of soils, than this one, and it is not, therefore, considered

advisable to enter upon any extended discussion of the subject at present. Two reliable analyses, however, of the grain and straw of wheat, made by Weber, in the laboratory; and according to the method, of H. Rose,* will be quoted here, in order to furnish an idea of the mineral ingredients whose presence in the soil is necessary to the nutrition of that grain.

	In the grain.	In the straw.
Percentage of ashes found, .	1.28	3.82
Constituents of ash.		
Potash, ...	23.18	0.68
Soda, ...	3.09	
Lime, ...	3.23	6.93
Magnesia, ...	11.75	1.69
Sesquioxide of iron, .	1.11	0.99
Sulphuric acid, ...		0.74
Amorphous silica, . .	1.18	67.90
Phosphoric acid, ...	46.36	5.05
Chloride of potassium, . .		15.13
Chloride of sodium, . .	10.00	0.89
	100.00	100.00

One of the many prominent points of interest here presented, is the large quantity of silica found in the wheat straw, (sixty-eight per cent.), insomuch that, the whole content of ash in the straw being 3.82 per cent., a simple calculation shows that a ton of such straw would contain more than fifty pounds of silica, and would require more than six tons of the marl I. A. to satisfy it with this element in its nutrition. So that upon a soil already deficient in amorphous silica, such marl, unless applied in a very large quantity, would not furnish it in the requisite proportion. Weber's analyses show also other ingredients in the wheat ashes, which do not exist in the marl, showing very clearly that a farmer who should attempt to restore exhausted wheatlands by the use of such a marl alone, would stand several chances of disappointment,

* Liebig & Kopp's Jahresbericht, für 1849, p. 656.

from the deficiency in the soil of necessary ingredients, unknown to him, which are not contained in the marl. These considerations illustrate how analyses of soils, when properly executed, as very few, it may be asserted, have been, may be of very high value to the agriculturist.

A comparison of the results of the two marl analyses, in consideration of the different depths from which they were taken, is interesting, and will be more so, when determinations of the quantities of the several soluble salts and of the nitrogen shall have been obtained. The main differences between the two are in the nature of the soluble mineral ingredients, which, in the surface-marl I. A., are principally chlorides, and in that from the lower part of the deposit I. B., principally sulphates; and in the organic matter, which, in the surface-marl, has been more altered by the action of atmospheric oxygen. More extended investigation in this direction will undoubtedly develope important practical results as to the selection of the marl, and its treatment preliminary to use.

Another result of the above analyses of Mr. Bonnell's marl, worthy of attention, is the large proportion of carbonate of lime which it contains, very few of the ordinary calcareous marls being equally rich in this ingredient. In fact, after deducting the water and organic matter, both of which would be expelled in burning it for lime, it contains about ninety-nine per cent. of pure carbonate of lime, and would undoubtedly burn into a very pure and excellent lime for building, and all other purposes.

II. A.

A grayish marl, taken from *four* feet below the surface of a deposit on the land of Isaac Coles, Montague Township, Sussex County.

A qualitative examination only of this marl has yet been attempted. It appears to resemble II. B. in every respect, ex-

cept in containing much less phosphoric acid, sesquioxide of iron and alumina, and more vegetable remains.

II. B.

A dark gray marl, from the same locality as II. A., but taken from *eight* feet below the surface.

When heated in a close tube, it behaves, in every respect, precisely like I. A.; also when heated upon platinum, a repulsive force for the metal being developed as in the case of I. A. The ignited marl evolves with chlorohydric acid a fœtid smell of sulphohydric acid, and with acetate of lead paper a strong reaction of the same is obtained. This was at first attributed to the presence in the charred mass of sulphide of calcium, proceeding from deoxidation of the considerable quantity of sulphate of lime found in the marl by the organic matter during the ignition, but it was found that the same evolution of sulphohydric acid took place from the substance when charred after complete removal of all traces of sulphates by long washing with water. It could therefore arise only from the presence of *sulphide of iron*, and as no traces of sulphohydric acid could be obtained from the unignited marl, bisulphide of iron, or *iron pyrites*, must be the ingredient in question, being converted into protosulphide by the ignition.

Water boiled with this marl acquires a yellowish color, and a strong smell like that in I. A., but also resembling some kinds of stagnant vegetable mud, remaining, however, perfectly neutral in reaction. Acid solutions have a light amber color, and smell somewhat of formic acid.

Its ingredients are as follows:

1. Soluble in water.

Sulphate of lime, large.
Ammonia-crenate of lime, } small.
Ammonia-apocrenate of lime, }
Chloride of sodium, considerable.

Chloride of magnesium, Chloride of iron, } traces.		
2. Soluble in chlorohydric acid.		
Lime, ...	9.71	Corresponding to carbonate of lime, 17.34 per cent.
Magnesia, ...	0.42	Corresponding to carbonate of magnesia, 1.09 per cent.
Carbonic acid, ...	7.25	
Combined water, Organic acids, } by direct determination,	3.19	
Sesquioxide of iron, mean of two determinations, ...	1.28	
Alumina, mean of two determinations, ...	2.12	
Phosphate of lime, ...	0.80	
3. Insoluble in chlorohydric acid.		
Amorphous silica,	1.21	
Organic matter, humus, decayed vegetable tissues, etc.,	5.52	
Coarse sand, with *debris* of minerals containing silica, alumina, oxide of iron, and magnesia, which may be considered as inert matter, Iron pyrites,	66.57	
Hygroscopic water,	2.08	
Nitrogen, undetermined.		
	100.25	

A most remarkable and wholly unexpected result of this analysis is the detection of *iron pyrites* in the marl, and from the fact of finding it also in another of the marls whose analysis is given below, the presumption would seem to be, that it is probably present in many of these deposits. Farther examinations will decide this point. In the mean time, its presence in these two marls can only be looked upon as highly favorable to their availability as fertilizers.

From the presence of an excess of carbonate of lime, it is impossible that any of the protosulphate of iron, formed by the

oxidation which iron pyrites, in the form in which it occurs in these marls, undergoes on exposure to the air, and which might be injurious to the soil, should exist in the mass without being immediately decomposed, with the formation of the powerful fertilizer, sulphate of lime, or *gypsum*. And that this action is continually going on in the mass, is indicated by the large quantity of sulphate of lime actually found in the aqueous solution. It may be said with certainty, with regard to such marls as these, that the longer they are exposed to the open air, in a moist state before use, the more powerfully fertilizing they will become. So that an important point as to the preliminary treatment of these marls is thus already definitely decided by these brief investigations. The origin of the iron pyrites in these deposits is a very curious question, and, in fact, the whole subject is one of great interest, and will amply repay fuller investigation. The presence of the iron pyrites was discovered at too late a day to admit of any attempt at determination of its quantity.

The quantity of carbonate of lime in this marl, as also in the one next described, is small, but on account of the presence of the sulphide of iron, and the continual formation of gypsum, which must consequently take place on exposure to the atmosphere, they will, in all probability, be found fully equal, if not much superior, in power, to the marl first described, although they will not be nearly so lasting in their action.

The other ingredients of this marl are not without importance, the proportions of amorphous silica and phosphate of lime, for example, being much greater than in the marl No. I.

III.

Marl from the land of Isaiah Vannetten, Montague Township, Sussex County, taken from four feet below the surface of the deposit.

A very dark colored, moist, peaty mass, containing remains

of decomposing rootlets. On drying by exposure to the open air, pulverizing and sifting, it was found to contain transparent silicious particles. When heated, it blackens, smokes, and burns with flame, leaving a residue which before the blowpipe assumes a reddish color, from the presence of oxide of iron. When heated in a close tube, it gives off much water, with ammoniacal and tarry products, and a strong tobacco-like odor like I. A. The charred mass, as in II. B., evolved with chlorohydric acid a large quantity of sulphohydric acid gas, and as in the present case no sulphates are present, which could be converted into sulphides by the organic matter on ignition, there can be no question of the presence of iron pyrites in the marl, even without further examination.

Water boiled with this marl acquires a yellowish color, and an odor similar to that in I. A., remaining perfectly neutral. Acid solutions have a dark amber color, which is not perceptibly discharged by boiling with nitric acid; and a very strong smell of formic acid.

The contents of this marl are:—

1. Soluble in water.		
Chloride of calcium, Organic salts of lime, } large indications.		
Chloride of sodium, Chloride of magnesium, Chloride of iron, } traces.		
2. Soluble in chlorohydric acid.		
Lime,	8.45	Corresponding to carbonate of lime, 15.09.
Magnesia,	0.43	Corresponding to carbonate of magnesia, 0.90.
Carbonic acid,	6.12	
Combined water, Organic acids, } by loss,	3.62	
Sesquioxide of iron, Alumina, }	2.49	
Phosphate of lime,	0.31	
3. Insoluble in chlorohydric acid.		
Amorphous silica,	1.15	
Organic matter, consisting of		

vegetable fibre in a state of decay, and products of its decay, such as humus, humic acid, etc.	8.20
Iron pyrites, Inert matter consisting of coarse sand, with silicates of alumina, oxide of iron and magnesia,	66.97
Hygroscopic water,	2.26
Nitrogen, undetermined.	
	100.00

The same remarks appended to marl No. II., apply with equal force to this, the two being almost precisely similar in composition. One important difference, however, is that this marl contains no sulphate of lime. On exposure, however, to the air, it cannot fail to be developed in the mass sooner or later. The proportion of phosphate of lime, also, is much smaller than in II. The proportion of decayed vegetable matter and of organic salts of lime is unusually large in this marl, and has undoubtedly been the means of protecting the iron pyrites from oxidation.

IV.

Calcareous sinter, from Metler's farm, Dingman's Ferry, Sandiston Township, Sussex County.

A yellowish gray mass, of spongy structure. It is naturally quite pulverulent, but on exposure to the atmosphere becomes so much more so as to be easily crushed to powder between the fingers like coarse chalk, a property which, of course, much enhances its availability as a fertilizing substance. When heated in a close tube, it gives off a faint trace of ammonia, with a little water. The ignited mass, on solution in chlorohydric acid, leaves a slight black residue, which, besides amorphous silica, contains carbon, thus indicating the presence of

organic matter in the substance. Water boiled with it evolves an odor like that of moist chalk, acquires no perceptible color or reaction, but dissolves salts of lime in appreciable quantities. Acid solutions have a light amber color and no smell.

The contents are:

1. Of the solution in water.

Chloride of calcium, considerable.

Ammonia-crenate and Ammonia-apocrenate of lime, Chloride of sodium, Chloride of magnesium,	traces.

2. Of the solution in chlorohydric acid.

Lime,	54.57	Corresponding to carbonate of lime, 97.44.
Magnesia,	trace.	
Carbonic acid,	42.57	
Sesquioxide of iron,	0.37	
Phosphate of lime,	0.22	
Organic acids, Combined water,	undetermined.	

3. Of the insoluble residue.

Amorphous silica,	1.00
Organic matter (humic acid),	0.17
Hygroscopic water,	0.32
	99.22

An analysis of a calcareous sinter, from this same locality, is given by Prof. Rogers in his report, page 109, where he describes it under the name of *travertin.* The results do not differ much from mine, except that no detection or determination of the important ingredient, amorphous silica, was effected. The presence of phosphate of lime also was not noticed by Prof. Rogers, owing to the entire want, at that time, of any method of detecting this highly valuable ingredient with certainty, except when present in large quantity. The specimen analyzed by Prof. Rogers also does not seem to have been of equal purity with mine, his analysis indicating but 93.53 per cent. of carbonate of lime, while mine gives 97.44 per cent.

The considerable quantity of chloride of calcium (also not

observed by Prof. Rogers), which is indicated by my analysis, is a very interesting fact. It is to be regretted that a specimen of the water from which this calcareous deposit was formed, was not also collected, in order that its composition might be compared with that of the deposit itself. Farther remarks upon the presence of the chloride of calcium are reserved until this can be done, and also a determination made of the amount of this salt contained in the mineral.

As remarked by Prof. Rogers, this calcareous sinter should give, when burnt, a very white and good lime.

V.

Calcareous sinter from the farm of Benjamin P. Van Sickles, Petersville, Sandiston Township, Sussex County.

Stalactitic in its structure, and contains small pebbles of quartz and sandstone. When heated upon platinum, it presents the same curious phenomenon of repulsion as I. A. The presence of organic matter was indicated by a brown color of the residue left after solution of the ignited substance in chlorohydric acid, which brown color disappeared before the blowpipe. The solution formed by boiling water with the pulverized substance has a smell like moist chalk, no color or alkaline reaction, and contains much chloride of calcium and other chlorides. Acid solutions have no smell, and little or no color.

1. Solution in water contains:

Chloride of calcium, considerable.

Chloride of sodium, } traces.
Chloride of magnesium, } traces.
Organic salts of lime. } traces.

2. Solution in chlorohydric acid:

Lime,	43.68	Corresponding to carbon. lime, 78.01.
Magnesia,	0.14	Corresp'ng to carb. of magnesia, 0.29.
Carbonic acid,	34.44	
Sesquioxide of iron, with trace of alumina,	0.80	
Phosphate of lime,	0.43	

Organic acids, } undetermined.	
Combined water, }	
3. Insoluble residue:	
Amorphous silica,	0.38
Organic matter,	0.20
Inert matter, consisting of silica, with traces of oxide of iron, alumina and magnesia,	19.39
Hygroscopic water,	0.36
	99.82

Work has been commenced also upon some other minerals, comprising some limestones and marbles, but the results are not complete enough to possess much interest, and I shall not therefore present them at present.

I am,

Very respectfully,

HENRY WURTZ,

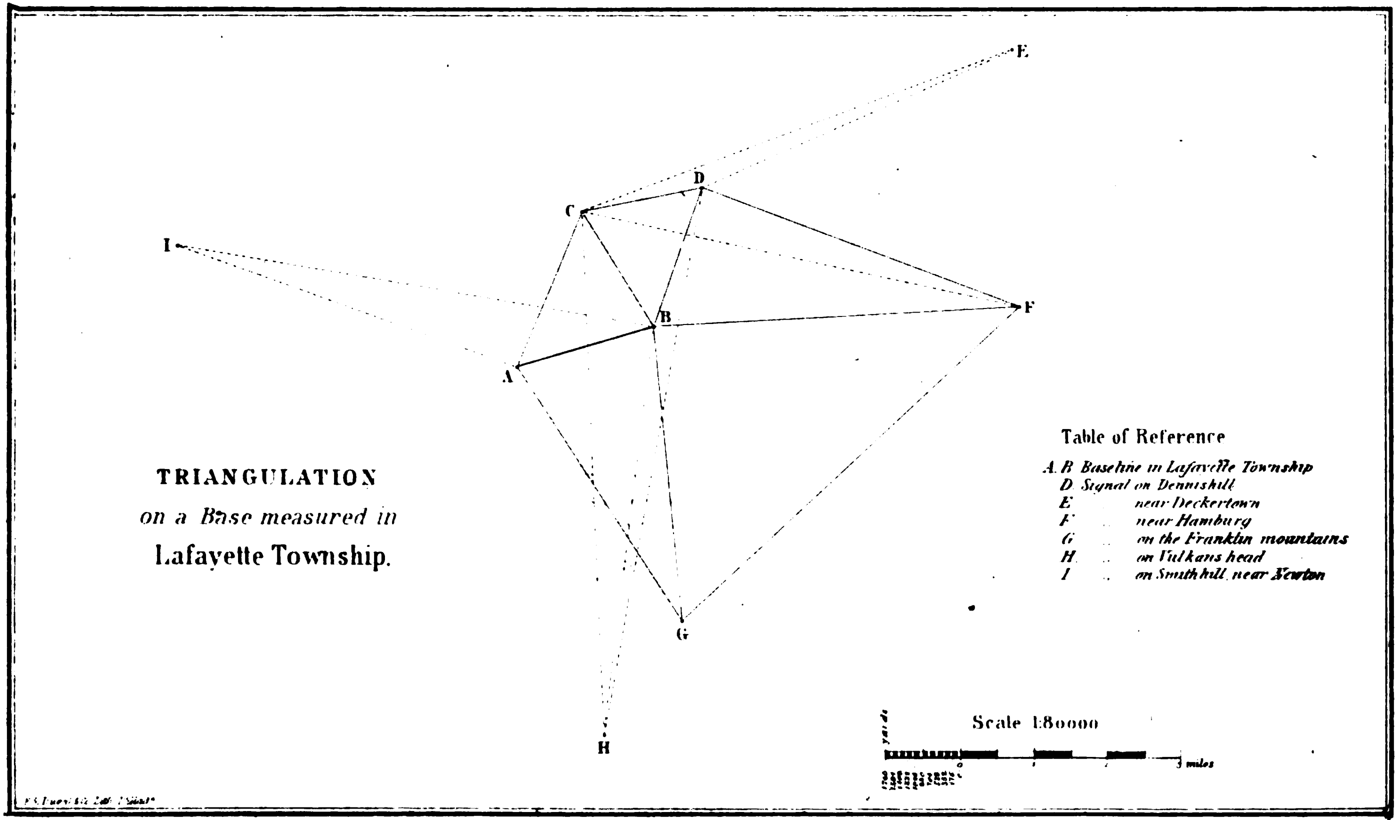
New Jersey State Chemist, Mineralogist and Metallurgist.

REPORT

OF EGBERT L. VIELE, TOPOGRAPHICAL ENGINEER.

HAVING been intrusted in June last with the duty of preparing a reliable map of the State, upon which could be accurately delineated the results of the geological explorations, it became my first care to determine the most feasible, and at the same time most economical method which could be pursued in prosecuting the undertaking. To this end, an examination was made of the records and maps deposited in different county seats, and also those on file at the State capital. From these no information could be obtained beyond that which is laid down on an existing map of the State, which map is merely a compilation from those records, showing the principal towns and roads, but exhibiting no reliable physical features, so important to the proper exposition of geological formations. Under these circumstances it was evident that an actual survey alone could furnish the map required. A plan based upon the extension of the coast survey over the State was submitted to the Governor, and discussed by several of the most eminent men in the State, then attending a session of the supreme court at Trenton. It was conceded to be the most judicious plan that could be followed, and adopted by the Governor as being the only one which would give to the State such a map as its geographical position and its great mineral wealth required.

The method pursued in a survey of this nature is as follows: A line from three to ten miles in length is measured with


E
D
C
I
F
B
A
G
H
TRIANGULATION
on a Base measured in
Lafayette Township.
Table of Reference
A. B Baseline in Lafayette Township
D Signal on Dennishill
E .. near Deckertown
F .. near Hamburg
G .. on the Franklin mountains
H .. on Vulkans head
I .. on Smithhill near Newton
Scale 1:80000
yards
0
1
2
3 miles

the greatest care and accuracy upon a plain as nearly level as can be found. This is called a *base line*, from each extremity of which, by means of a theodolite, the angles are measured, which are included between several prominent surrounding objects previously selected as trigonometrical points. From each of those points the angles are measured between the lines joining the points and the extremities of the base line. There is thus formed a series of triangles, from the known parts of which the unknown are determined by calculation, and we thus ascertain the length of the sides of the triangles or the distances between the trigonometrical points. From these sides as bases other trigonometrical points are determined, until the entire tract of country to be surveyed is covered over with a network of triangles, of as large a size as is consistent with the means employed. This is called a primary triangulation, within which a series of secondary triangles is formed in the same manner. The interior details between the secondary points are filled in by means of the plane-table. These details consist of the contour lines of the elevations, or horizontal sections of the hills, taken at equi-distant intervals—the direction and sinuosities of the water courses; the houses, roads, farm lines, etc. Observations for latitude and longitude are made at several of the most conspicuous stations, from which the geographical position of all the points can be determined, and their places projected on the map with extreme accuracy.

For the purpose of the Geodetic Survey, the coast of the United States has been divided into eleven sections, in each of which a base line of from five to ten miles is measured. The coast of New Jersey is included in the second of these sections, the base of which is on Fire Island. The primary triangulation extends across the State from Amboy to Trenton, and down the Delaware River. The secondary triangulation follows the same course, and also extends along the whole coast. About two thousand square miles of topography have been completed, based on this triangulation. Observations for latitude and azimuth have been made at a number of stations of the primary triangulations. The difference of latitude,

longitude, and azimuth, between these and the other stations have been compiled, and the results published in tabular form, giving the names of the several stations or triangulation points, the latitude and longitude of each station, and the distances between the several stations.

The course to be pursued in completing the survey of the State is a very plain one: simply to begin where the coast survey left off, carry out the triangulation, and fill in the topography. Half the labor and expense of the undertaking is saved to us, by what has already been accomplished. The records of the work done are complete for every step of progress, and a monument of some kind marks every triangulation point. Had the appropriation of last year been sufficient, operations would have been commenced on a side of the coast survey primary triangulation as a base, and the topographical parties would have worked from the centre of the State to the north and south simultaneously. Under the circumstances, however, it was deemed most judicious to show as much topographical and geological development as possible, in the short time that would elapse before the meeting of the Legislature, in order that the whole subject might be presented in a clear light. To this end, the boundary line between New York and New Jersey was selected as the base of operations, on the supposition that this line, having been laid down by a joint commission, offered a well-defined base line. Time, however, and individual carelessness, had served to obliterate or destroy every vestige from the Delaware to the Blue Mountains; even the initial point was wanting. A serious delay occurred in re-establishing this line so far as the records that could be obtained enabled it to be done. The line determined on coincided with the one formerly regarded as the boundary line in the division of property bordering upon it; although, during the last few years, it had been shifted to one side or the other, according to the ideas of the local surveyors. Having established a starting point, levelling for a geological section was commenced along the boundary line, and a base for topography was measured in the township of Montague. The

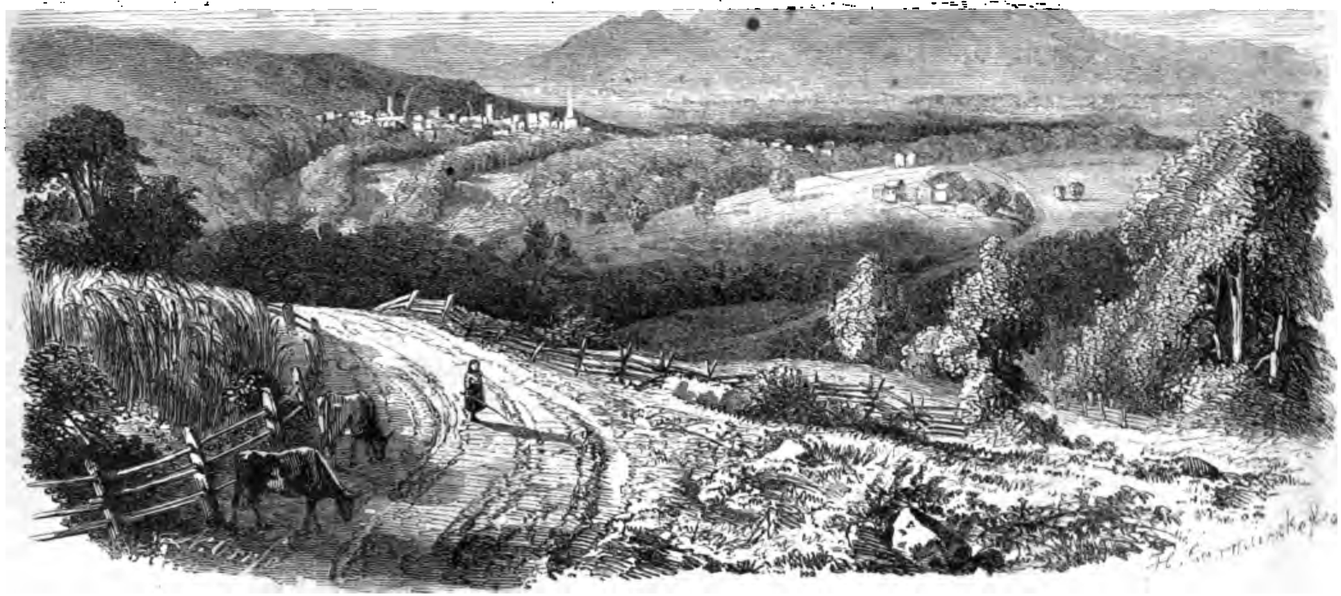
principal points were established by a reconnoissance, in order that the topography might be checked by a secondary triangulation when a theodolite could be procured. A second base line was afterwards measured in the township of Wantage, and the same course pursued as in Montague, and so on for all the townships that were surveyed. But one plane-table was in use until September, when one was borrowed from the Coast Survey, and afterwards a theodolite from the same source. From the beginning of the work, Professor Bache, the Superintendent of that Survey, has taken a cordial interest in its progress, and expressed a willingness to aid it by any means in his power.

A summary of the operations of the past season is as follows:—The party entered the field on the eleventh of July, consisting of three principal assistants, aided by four volunteers, who gave their services in return for learning engineering. Three more assistants were added when the instruments were received from the Coast Survey. On the 30th of November the field operations were brought to a close. During that period, the parties completed three hundred and sixty-one miles of topography, (being three fourths of the county of Sussex,) and seven hundred miles of levelling for geological sections, besides many minor details. In consequence of the late period at which the theodolite was received, and the inadequacy of the means, the complete triangulation of the county was not accomplished, but enough was done to test the general accuracy of the topography. A sketch of this accompanies the report. Since the parties left the field, a sufficient length of time has not elapsed to complete in the office all of the work which has been done, but so much as may be mapped at the time the subject occupies the attention of the Legislature, will be forwarded to Trenton for inspection. The scale upon which it is proposed to execute the map, is 1–80,000, the same as the published maps of the Coast Survey, and as the topographical map of France. This is somewhat less than one inch to the mile, which is the scale of the ordnance map of England. The scale proposed for the county maps is 1-30,000, or about two inches to the mile.

It might appear almost superfluous to enlarge upon the nature and importance of this work, considered with reference to the intrinsic value of a topographical map of the State. The great attention which has been given in this country, during the last few years, to the study of physical geography, and the rapid strides of education and intelligence, has created a demand for something more than mere guide maps of the different States of the Union. The National Legislature, true to the impulse of the times, has nobly responded to the efforts of science—hundreds of thousands of dollars have been freely expended in exploring and preparing charts of the seaboard. A network of triangles covers the coast from Maine to Texas—minute soundings have brought to light the hidden rock and treacherous shoal. The capacities of the inlets, rivers, and harbors of the Atlantic coast have been determined, and a basis of accurate survey established, which the States bordering on the ocean are invited to take advantage of, and continue this great work, so that the States adjoining them may take it up and continue it on until it meets a corresponding effort from the Pacific side. Thus giving to the country and to the world what England commenced a hundred years ago—what France, Italy, Austria, Norway, and Sweden and Russia, have spent millions to obtain, viz:—A correct topographical map, from which future generations may learn the nature and extent of the vast resources, developed and undeveloped, of this favored land. Under the auspices of an enlightened legislation, the State of New Jersey has been the first in the Union to commence this undertaking on purely correct principles. Its completion will be an era in her history, and a lasting monument of the intelligence of her people.

EGBERT L. VIELE,
Topographical Engineer.

DR. WILLIAM KITCHELL,
State Geologist and Superintendent.



WASHINGTON AND WATNONG MOUNTAINS, AND MORRISTOWN, FROM LOANTAKA, MORRIS CO.

SECOND ANNUAL REPORT

ON THE

GEOLOGICAL SURVEY

OF THE

STATE OF NEW JERSEY,

FOR THE YEAR 1855.

TRENTON:
PRINTED AT THE TRUE AMERICAN OFFICE.
1856.

LIST OF ILLUSTRATIONS.

WOOD CUTS.

LITHOGRAPHS.

NOTE.—The vertical sections of the mines are drawn on a scale of 160 ft. to one inch. The part in black represents the extent to which the ore has been removed; the white lines represent the position of the shafts, levels, and inclined planes; and the dotted lines represent the position of the faults.

The transverse sections of the Hibernia mines are drawn on the scale of 20 feet to one inch.

ERRATA.

On page 45, tenth line from bottom, read "are" for "is."

" 46, sixteenth line from top, read "were" for "was."

" 118, eighth line from bottom, read "northeasterly" for "southeasterly."

" 119, sixteenth line from bottom, read "considerable" for "inconsiderable."

" 128, fourteenth line from bottom, read "Sussex" for "Passaic."

" 130, third line from bottom, read "northeastern" for "northwestern."

" 143, sixteenth line from bottom, read "southeastern" for "southern."

" 163, fifth line from bottom, read "worked at the present," instead of "worked the present."

CONTENTS.

REPORT ON THE GEOLOGICAL DEPARTMENT; NORTHERN DIVISION OF THE STATE.

To His Excellency,

RODMAN M. PRICE,

Governor of New Jersey.

Sir:

I have the honor herewith to submit to you the Second Annual Report on the Progress of the Geological Survey of the State of New Jersey, for the year 1855.

Very respectfully, your obedient servant,

WILLIAM KITCHELL,

Superintendent of the Geological Survey of New Jersey.

Newark, N. J., January, 1856.

REPORT

ON THE

ORGANIZATION OF THE SURVEY,

AND FINANCES.

REPORT.

In my last Annual Report, the plan adopted for prosecuting the Survey divided it into four principal departments:

1st. THE TOPOGRAPHICAL AND TRIGONOMETRICAL DEPARTMENT.

2d. THE GEOLOGICAL DEPARTMENT.

3d. THE PALÆONTOLOGICAL DEPARTMENT.

4th. THE CHEMICAL AND MINERALOGICAL DEPARTMENT.

It was then stated that the object of the topographical department was to furnish a correct and minute topographical map of the State, on a scale sufficiently large for the accurate delineation of the geological features of the State, as well as for the proper presentation of data from which sections representing the relative position and thickness of the various formations of rocks, could be constructed.

Deeming this the true basis, or ground work, of correct geological research, it has been my chief aim to promote its rapid advancement; and, consequently, the greater part of the appropriation made at the last session of the Legislature has been devoted to it. By reference to the report of Mr. E. L. Viele, the State Topographical Engineer, it will be seen that no time has been lost in organizing parties, and sending them into the field, as early as the season would allow. In order that the work might advance with an equal pace, both in the northern and southern divisions of the State, the same number of parties was sent into both divisions; and, subsequently, a triangulation party was organized, the operations of which, in connection with those previously conducted by the U. S. Coast Survey, have extended

the triangulations nearly over the entire State. For the purpose of rendering each topographical party available in advancing the geological researches, as far as time could be appropriated, and the nature of their labors would allow, the following instructions were given to the first assistant of each:

"You are hereby instructed, in addition to your duties as assistant engineer, to make the following observations and investigations in that section of the State over which your labors extend:

"1st. Physical Geography. Describe the physical features of each township, embracing its mountains, hills, elevated lands, plains and valleys; their extent, direction, and height; their declivities or surfaces—whether level, gently inclining, or undulating, or precipitous; whether cultivated or uncultivated; covered with rocks in place, drift, or alluvion. Note, particularly, the most elevated mountains and hills, and describe the nature and extent of the scenery from their summits. Ascertain with precision as many elevations above mean tide, as well as the water level in the vicinity, as possible; especially at marl pits, quarries, mines, and wherever useful minerals are found. Describe all rivers, lakes, ponds, and springs; their origin and course; extent, depth, velocity of current, availability for water power, or other useful purposes; by what animals inhabited, and their abundance, etc.

"2d. Geology. Examine and note minutely all geological formations, viz: The different varieties of rocks, including all layers of sand, gravel, clay boulders, etc.; their strike, dip and extent; and represent their relative position by sections, diagrams, and drawings; and delineate the boundaries of each formation on the map; describe their lithological, mineralogical, and chemical characters; their texture, hardness, cleavage, and durability; their resistance to atmospheric agencies, and adaptation to economical purposes, as materials for building, paving, macadamizing, etc. Examine their constituent minerals; their

form, size, color, hardness, relative position, and abundance; their resistance to the various agencies to which they are exposed —whether one is more easily acted upon than another.

"3d. METALLIFEROUS DEPOSITS. Search for, and examine, minutely, all metalliferous deposits, and locate them on the map. Determine their character, whether superficial, stratified, or unstratified; if unstratified, whether they are regular or irregular; if regular, whether they are segregated, gash, or true veins; whether they are of igneous or aqueous origin. Describe their geological position; the character of their wall rocks, their strike, dip, thickness, and extent; the character, quality, and abundance of the ore, and its accessibility for mining. Examine, and locate all mines, quarries, and deposits of fertilizers, such as marl, phosphate of lime, peat, and muck; ascertain their facilities for being extracted, and the best means of placing them in market. Ascertain the names of all mines, quarries, furnaces, forges, and rolling mills; the names of their owners; by whom, and to what extent, they are worked; the use and disposal that has been made, and is now made, of their productions. Collect historical data concerning them, and all other matters of interest in reference to them, from their commencement to the present time.

"4th. SOIL. Describe the character of the soil, whether consisting of sand, gravel, clay, and vegetable matter, or any mixture of them; its adaptation to the growth of particular plants; the usual crops grown upon it; the average yield per acre; and the means resorted to for increasing its fertility.

Examine the natural growth of trees, shrubs, and plants; their species and abundance.

"5th. METEOROLOGY. Keep a register of the weather, prepared from daily thermometrical and barometrical observations. Describe all storms and showers; their commencement, duration, and severity. Note localities where lightning has struck; together with its effects and attendant circumstances. Make inqui-

ries in regard to the prevalent diseases of particular districts, such as intermittent and remittent fevers, etc; the season of the year at which they generally prevail, and to what cause they may be ascribed. Ascertain if any meteorological observations are, or have been, regularly made in the vicinity, and for what length of time, and by whom made.

"6th. SPECIMENS. Collect three suites of specimens of all the varieties of rocks, minerals, ores, marls, clays, sands, peats and fossils, found in each township. Let them be uniform in size, viz: four inches square, and two inches thick, except when isolated or grouped crystals and fossils require specimens of greater or less dimensions. Obtain them directly from the formation, deposit, or mine, and let them possess fresh and clean surfaces.

"The rocks, clays, marls, peats, sands, and fossils should be characteristic of formations, strata, beds and layers. The minerals, ores, rocks, etc., of economical value, should be characteristic of localities, such as deposits, mines, and quarries.

"Label each specimen (in accordance with the accompanying label) with its name, (when known) its precise locality, date of collection and name of collector; and carefully wrap it in strong thick paper.

"Let the label of each specimen refer to the particular page of a note book on which it is described. Carefully pack each series of specimens in strong boxes, in such manner that their surfaces cannot come in contact, or be scratched or injured by rubbing together. The weight of each box should not exceed one hundred and fifty pounds.

"Choice specimens of crystallizations and fossils should be wrapped in cotton and packed separately.

"Prepare a list of specimens in each box, numbering each to correspond with a number on the outside of the wrapper, and place it on top of the specimens, when the box is filled.

"Mark distinctly, and number, each box to correspond with

the note book in which the specimens are described, and address it as follows: [———————]

"Whenever an opportunity may allow, collect specimens of Natural History, such as plants, birds, animals, reptiles, fishes, insects, bugs and infusoria. Preserve and pack them carefully, in accordance with the accompanying directions."*

In organizing each plane-table party, it was made an object to obtain a first assistant, who, being somewhat acquainted with geological research, should render as much aid as possible in complying with the above directions. Although there was some difficulty in procuring a competent assistant for each party, still, by a little instruction in the field, the majority of them have been able to render efficient service in collecting a fund of information, which may be made available in various ways.

As the object of the survey is not simply a scientific description of the topographical and geological features of the State, but also their economic relationship, it has been deemed advisable to embrace, in this report, an enumeration and description of the internal improvements of the State, together with all the indices to the true mode of opening every portion of its territory and developing its resources.

Intending to conduct, in person, the geological researches in the northern division of the State, I entered the field as early in the spring as the weather would allow, and made a general reconnoissance of Morris County, and of a part of Passaic and Warren. But finding that the general superintendence deprived me of the time so essential to the rapid advancement of the detailed examinations, an assistant geological party, consisting of Mr. Ernest Haeusser, assisted by Mr. E. F. Baldwin, was organized on the first of June, and sent into the field, with instructions to make detailed examinations of the azoic rocks of the Highlands.

* Directions for collecting, preserving and transporting specimens of Natural History, prepared for the use of the Smithsonian Institution, 1854.

On the twenty-third of September a party of engineers, consisting of Mr. R. W. Patterson, assisted by Mr. W. Wagner, was organized, and entered the field, in the iron region of Morris County, for the purpose of assisting in making local surveys of its principal mines, and mine tracts. Their labors have resulted in a survey of both the surface and underground workings of the principal mines, from which sections and diagrams representing the nature and position of the deposits, and the extent of their workings, also topographical maps of the Hibernia and Andover mine tracts have been made. Some of these sections are included in the annexed report on the Highlands.

Mr. J. Morris has been engaged during a part of the summer in preparing profiles for geological sections, deduced from notes and surveys gratuitously furnished by Mr. Bassinger, Chief Engineer of the Morris & Essex Rail Road. These sections are reserved for the final reports on the counties of Morris and Warren, now in course of preparation.

Since the termination of the field operations on the first of December last, there has not been sufficient time for collecting and arranging the materials necessary to so systematic a report as could be desired; nor has there been opportunity for making the qualitative chemical examinations belonging to an accurate description of the rocks; and consequently the annexed report on the progress of the survey in the Highlands is submitted merely as a partial statement of the many detailed examinations in this most interesting and important district.

The Assistant Geologist, Professor George H. Cook, in charge of the southern division of the State, has been actively engaged in prosecuting the field work, as may be seen by the results of his labors included in the annexed report. At intertervals, during the year, he has been assisted in his researches by the following gentlemen: Messrs. Nicholas Wyckoff, and Alexander M. Kelvey, who have aided him in running levels for

sections, which are reserved for the final report; Mr. Abram Van Nest, who has assisted him both in the field and the laboratory; Mr. Julius Kock, who has been occupied in making analyses of marls, clays, etc., the results of which are herewith submitted; Dr. P. D. Knieskern, who has been engaged in collecting fossils, his ardent devotion to the study of which, together with his intimate acquaintance with that portion of the State, have enabled him to render very important service in this department; and Mr. William Snowden, who has aided him in the geological examination of Salem County.

In addition to the levels and profiles made by the above named levelling party, Mr. Martin Coryell, Chief Engineer of the Delaware and Chesapeake Canal, has very kindly furnished a profile of this canal, with an account of the green sand stratum through which it passes. Copies have also been obtained of levels on the West Jersey Rail Road, and on the Camden and Pemberton Rail Road, through the courtesy of General William Cook, Chief Engineer of the Camden and Amboy Rail Road.

Thus, it will be seen that the geological department of the survey is in a condition to be completed and reported upon finally, by counties, as rapidly as the topographical maps are finished.

At the commencement of the year, Mr. Henry Wurtz, who is in charge of the chemical and mineralogical department, began to fit up the laboratory with the necessary reagents, and apparatus for making the chemical and mineralogical examination of the minerals, ores, etc., collected by those in the field. The difficulty experienced in obtaining pure reagents from the shops, rendered it necessary to prepare them in the laboratory; and this, together with other hindrances, delayed the commencement of the examination of the specimens, until a late period in the spring. As it was determined to confine the geological researches in the northern division, for the year, to the metalliferous district of the Highlands, it was deemed advisable

that Mr. Wurtz should devote a portion of the season to examining the principal mines of this district, and to selecting specimens therefrom for the State and County Cabinets, as well as for analysis. In accordance with this plan he spent the entire summer season in the field; and the results of his labors, embodied in the report, are of a most interesting and important character, tending not only to benefit the iron masters of this region of the State, in their mining and metallurgical operations, but also adding materially to the fund of chemical and mineralogical science.

The following letter, accompanying the report, will give an idea of the nature and extent of the work now in progress, the results of which must be deferred until the preparation of the county reports:

NEW JERSEY STATE LABORATORY,
Trenton, January 1, 1856.

TO DR. WM. KITCHELL, STATE GEOLOGIST:

SIR:—On presenting my Report for the last year, it is expedient that I should make a few remarks by way of explanation.

It was hoped that it would be possible to introduce into the present report a considerable quantity of material in addition to that which has been reported, and among other things, the results of an extensive series of thorough and elaborate quantitative analyses, which are now in progress, of the ores of many of the mines reported upon. The time, however, has been so consumed by the labor required for reducing into orderly and intelligible shape the great quantity of materials gathered in this department during the past season, so as to enable me to show the nature of the work begun, and the progress that has been made, that after making every possible exertion, I am compelled reluctantly to defer the analyses until a future report.

It is also a part of my intention to collate and condense, as

much as possible, into tabular forms, the heterogeneous mass of observations which I have made upon the mineralogy of the iron region, and upon the structure of the ore-beds, and thus to present them in such a shape that generalizations may be made, and principles deduced, to serve as guides in our future operations; and in this connection to bring forward, also, a number of general views and theoretical considerations which have occurred, bearing upon the important subject of the origin and mode of formation of the ore-beds.

Want of time, however, has made the introduction of these things also impossible; and it may be better, moreover, that the publication of such generalizations, and the theoretical views deduced from them, be postponed until the explorations of another season shall have furnished us with a still larger and firmer foundation of facts upon which to base our superstructure of hypothesis.

Besides all this, there is in my possession a considerable quantity of actual material of a miscellaneous character, which it has not yet been possible to arrange in a presentable shape, and which must also be introduced into a subsequent report.

No light portion of the labor has been the quantitative examination of the minerals, which has been carried to so great a degree of minuteness that I may say that scarcely an assertion as to the specific identity of a mineral occurs in the report, which does not rest upon analytical evidence. In every case where reasonable doubt could exist, it is sufficiently expressed in the context. For efficient assistance in this important part of the work, it is just that I should acknowledge my especial indebtedness to Mr. Howland Bill, pupil in this laboratory, by whom a large number of the analyses were made.

I am, very respectfully,

HENRY WURTZ,

State Chemist, Mineralogist, and Metallurgist.

The limited time left to Mr. Wurtz was insufficient for him to enter upon, and complete a series of analyses of marls and clays, required by the Assistant Geologist in arriving at reliable conclusions connected with the economic geology of the southern division of the State. Under these circumstances an assistant chemist was employed, who, under the direction of Prof. Cook, has been engaged in the desired investigation, the results of which are included in the report of the Assistant Geologist.

This very important department of the survey being now fully organized, and an ample supply of material collected for examination, every effort will be made to advance its operations as rapidly as the circumstances and the nature of the investigations will allow.

In the early part of the year the palæontological department, until this time vacant, was filled by the appointment of Mr. T. A. Conrad, an early pioneer in palæontological research, not only in this, his native State, but in various States of the Union. From the wide reputation of this gentleman, derived from the results of his labors, both as a minute observer and sound reasoner, the State had grounds for congratulating itself upon an appointment that promised so auspiciously in this very important department. But the condition of Mr. Conrad's health, soon after his appointment, would not permit him to enter upon his duties; and he, consequently, resigned his position in the survey.

A correspondence was then opened with the distinguished palæontologist, Prof. James Hall, who was, at that time, about to visit the Western States, for the purpose of making some researches in the palæozoic rocks of that region. It was impossible to procure his services for the past year, but, since his return, within a few weeks, arrangements have been made to place him in charge of this department. He will be able to devote to the work as much time as the progress in the county surveys will require, together with all that will be necessary for a final report on the palæontology of the State.

CABINET. During the year about three thousand specimens have been collected for the State and County Cabinets; but as, on the part of the State, no rooms have been provided for their accommodation, much time has been lost in the unpacking and repacking incident to their examination. The specimens, so far as they have been collected, in connection with the detailed geological researches of townships, are now ready for arrangement, and it is very desirable that something should be done as soon as possible, in order that the minerals intended for the local arrangement, viz: by townships, may be classified, and placed in accordance with the preparation of the final report on each county.

DRAUGHTING AND ENGRAVING. In order that the county maps should, in accordance with the law, be ready to accompany the final county reports, and in order that accuracy of execution and economy should be united, it was deemed advisable to have the engraving performed under our own supervision. As soon, therefore, as the field-work of Sussex County was finished, a map of it was commenced, and is now nearly completed. Maps of counties will, in like manner, be commenced, and carried on, as rapidly as the work in them shall be achieved; and thus, by sections embracing a single county each, the whole State will finally be delineated upon a single map. By causing the maps to be engraved under our own supervision, directly from the plane-table sheets, a great amount of labor and expense has been saved in dispensing with the draughting of the topography upon paper, a task which would have been otherwise necessary. With the same end in view, the various illustrations accompanying the report, have been engraved from transfers made upon wood, directly from the rough sketches, and by the same artist who took them in the field. These illustrations are intended to accompany the final county reports, and are submitted at this time rather as specimens of the style of their execution. They were sketched in the field, and, (with the exception of those taken in Sussex

County, which are the work of Mr. Francis E. Berier,) were drawn on wood by Mr. Herman Carmiencke, and engraved by Mr. N. Orr.

It will thus be perceived that, in the preparation and arrangement of the materials gathered in the field, and elsewhere, everything has been done with a view to the perfection of the county reports, from which, ultimately, a systematic report on the whole State may be prepared.

Final Reports. The topography of two counties being already completed, and that of several others nearly so; and, the other departments of the survey being in a corresponding state of advancement, the final county reports will be forthwith commenced, and at an early day submitted. The general survey will at the same time be continued, and reports thereon annually presented in accordance with the law.

Finances. The following abstract of expenditures includes not only the expenses of the field-work, for which the estimate of last year was made, but also those of the draughting, of the engraving, and of the office, for which a distinct appropriation should be made.*

EXPENDITURES.

Topographical Department - - -	$9,361 91 1-2
Geological Department - - -	5,316 05 1-2
Chemical Department - - - -	2,449 57
Palæontological Department - -	000 00
Miscellaneous, Engraving, etc. - -	810 00
Total - - - - - - - -	$17,937 54
Receipts - - - - - - -	$16,000 00
Apppropriation - - - - - -	$20,000 00

* For particulars, reference may be made to the accompanying vouchers, abstracts, accounts current, and annual return.

The following estimate is for the prosecution of the survey, both in the office and field, for the coming year:

Topographical Department - - - - -	$10,000
Geological Department - - - - - -	6,300
Chemical and Mineralogical Department - -	2,700
Palæontological Department - - - -	1,000
Engraving and Draughting - - - -	5,000
	$25,000

As this will be sufficient to prepare the maps and cuts for at least three, and perhaps four counties, in addition to extending the field-work over the greater part of the State, upon which reports may be rendered next year, I would recommend that arrangements be made for the disposal of the County reports either by sale or gratuitous distribution. The latter method does not seem to be the more advisable one, as the demand for the work, under such circumstances, would doubtless exceed the supply. The former method would place it in the hands of all who choose to avail themselves of it, and, at the same time, would reimburse the treasury, sufficiently to defray at least the expense of engraving and printing.

In concluding this report, I would express my thanks and obligations to the numerous friends of the Survey who have rendered assistance in furnishing information, and collecting specimens pertaining to its various departments, as well as to the various branches of Natural History—a subject which, I hope, will at no distant day be added to those now under investigation. Especially do I desire to express my indebtedness to the officers in charge of the several departmens, all of whom have labored with an assiduity and energy indicative of a love of science and the best interests of the State.

WM. KITCHELL,
Superintendent, and State Geologist.

REPORT

ON THE

TOPOGRAPHICAL DEPARTMENT.

Dr. William Kitchell, *Sup't Geological Survey:*

Sir:

I herewith submit the report of the Topographical Department of the State Survey, for the past year.

I have prefaced it with a few remarks on the principles upon which the Survey is conducted, in order to make it more comprehensive as well as more interesting.

The report is from its nature incomplete, as it is only in a final report that positive results can be looked for.

The work accomplished will be found to compare favorably with any other of the same nature, both in amount, accuracy, and economy.

Your obedient servant,

EGBERT L. VIELE,

State Topographical Engineer.

REPORT.

The topographical survey of the State has for its object, to furnish a correct basis for the examination and delineation of the geological formations which occur within its limits, and at the same time to supply a complete physical map of every county, exhibiting all the features of the surface.

TOPOGRAPHY.

Topography may be defined as a description of the features of a country, either verbal, written, or represented on a map by means of conventional signs.

The latter conveys to the mind a more perfect idea than any other, since it is an exact copy of nature on a small scale.

In order the more clearly to understand the method pursued in the graphic representations of the surface of the earth, let us conceive a horizontal or level plane to be passed underneath a limited area of ground, and that from every point of the surface perpendiculars be let fall upon this plane. The feet of the perpendiculars, or the points of their intersection with the plane, will be the horizontal projections of all the points on the surface, and will form by their connection a correct representation of the natural and artificial features of the country.

If this representation be reduced to a smaller scale, and drawn upon paper, we shall have a topographical map upon which we shall see traced the sinuosities of the streams and roads, the outlines of the woods, the boundaries and extent of the fields and enclosures, the localities of the houses, etc.

That the inequalities of the surface may be clearly represented, we resort in the same connection to a system of contour

lines, which are the lines in which the surface of the hills would be intersected by a series of imaginary horizontal planes, taken at equidistant vertical intervals.

These lines of intersection are projected upon the principal horizontal plane or plane of reference. The spaces between the contour lines are filled by short vertical lines of greatest declivity, drawn normal to the upper curves, and terminated by the next lowest successively.

It is evident that the nearer the lines approach each other in projection, the greater the declivity of the slope.

THE PLANE TABLE.

The most useful and convenient instrument used in delineating topography is the plane table, which consists principally of a small rectangular tablet, about one foot square, secured to a tripod, and having an arrangement for making it level. A sheet of paper designed to receive the map, is stretched upon the surface. Accompanying the table is a ruler, to which is attached a telescope, whose line of collimation is in the same vertical plane with the edge of the ruler.

To use the table it is necessary to determine at first by measurement the exact length of a line upon the ground. Then placing the table at one extremity of this line we fix with a needle that point on the table which corresponds with the point at which we stand. Resting the edge of the ruler against the needle, we direct the telescope to the other extremity of the line and successively to various prominent points, drawing lines upon the paper to correspond to their direction. Then laying off according to the scale the length of the measured line, we proceed with the table to the other extremity of this line, and having fixed its position on the table, we observe from there the objects seen from the other end, drawing in like manner lines corresponding to their directions. The intersections of these last lines with those first drawn, are the positions on the map

corresponding to the several observed points. The roads, streams, and contour lines intervening between the points determined, are sketched in by the topographer.

For a limited extent of surface, the liability to error in this kind of work would not be very great, but for an extended area it is necessary to resort to a more accurate method for determining the positions of the several points and the distances between them. It is obvious that a linear measurement along the surface would not accomplish this object, since the inequalities of the ground, and the many obstacles which would be met with would greatly increase the chances of error.

To obviate this, we have recourse to a system of triangles, by means of which we measure in the air, above all obstacles, the distances between the points.

When the area to be surveyed is very extensive, such as that of a State or Territory, in addition to determining the distances between the several points, we have to determine the actual position of these points upon the surface of the earth, or in other words, their latitude and longitude. These last operations are termed Geodetic.

GEODOSY.

Geodosy is the science by which we determine the figure and dimensions of the earth, and the exact position of all points on its surface.

The first step to be taken in a Geodetic survey, is to make a general reconnaissance or examination of the country, for the purpose of determining the most elevated or most advantageous points, which could be used for trigonometrical purposes.

The next is the careful measurement of a base line, suitably located upon a plane as nearly level as possible, having previously selected certain elevated points in the vicinity, one or more of which might be seen from the extremities of this base line.

We then measure with a theodolite, the angles included between the base line and the lines drawn from the extremities to

the several visible points, which are called stations. From these observations we are enabled to determine the length of these lines, which in their turn serve as bases to determine the length of other lines. In this manner we cover the whole area to be surveyed with a net work of triangles.

Observations for the determination of latitude and longitude are made at both the extremities of the base line, and also at most of the principal points.

The triangles are made as large as the nature of the country, and the power of the instrument will admit, both on account of economy in time, labor and expense, as well as to avoid error, since the larger the triangles the less the chance of error. Within these large triangles we select other stations, which are connected with the first by observations.

The smaller triangles thus formed are called secondary, the former being designated as primary. Within the secondary, still another series is formed called tertiary, which last serve as bases for the work on the plane table sheets.

Various elements enter into the calculations of the primary triangles, such as spherical excess, observation, error, etc., the details of which it is not deemed necessary to enlarge upon.

MAPS.

Having indicated the nature of the operations in the field, the next step is to transfer this field work to paper, or in other words to construct a map.

If we could trace upon a sheet of paper the meridians of longitude, and parallels of latitude, precisely as they are represented upon a globe, we should have no difficulty in referring each locality to these conventional lines, and thus constructing a map which would be an exact representation of nature.

But the surface of the earth being spherical, we cannot represent it upon a plane surface, without altering to a greater or less extent the proportions of the territories, the distances between

the places, the sinuosities of the rivers, etc. We must therefore resort to some method by which these representations can be made, while distorting as little as possible, the actual distances.

To make a map of the earth we represent each hemisphere in perspective. That is to say, we suppose the eye to be situated at some arbitary, but fixed position in space, and that a transparent plane is interposed between the eye and the hemisphere. If we conceive every point of the hemisphere to emit a ray of light, each ray would pierce this transparent plane in a point, and supposing the plane to retain this image, we would have a representation of the hemisphere, as it appears to the eye.

When we wish to make a map of a more limited extent of country, such as a State or Territory, we resort to an arbitrary system of right lines or curves to represent the meridians and parallels; constructing a net work upon which we place each locality according to its latitude and longitude. This is called a projection. There are various methods of projections, all possessing a certain degree of merit. Of course those are the best which approximate nearest to an actual representation. The method of projection which has been selected, as offering the most advantages in constructing the map of New Jersey, is the one which has been generally applied to the topographical maps, formed on the Geodetic surveys of many of the European States. To construct a map on this projection, we assume first a central parallel. Along the parallel, a cone is conceived to be tangent to the sphere, and we develope the central meridian on that element of the cone which is tangent to it.

Then developing the cone on a tangent plane, we find the central parallel falling into a curve, with its centre at the vertex, and the meridian into a right line. Laying off upon the developed meridian certain elementary distances, we draw through the points of division a series of arcs concentric with the developed parallel. The spaces between these arcs are evidently the developement of the zones between the parallels.

All these zones have in devolopement the same relation to each other, and the same length and width as they had on the spheroidál surface; the total area remaining unchanged.

Each meridian is so traced as to cut each parallel in the same point, in which it intersected it on the sphere. For areas of no very great extent the intersections are almost rectangular. The distânces along the parallels are strictly correct, but distances along the meridians increase in proportion to the diminution of the cosine of the angle between the radius of the parallel, and a tangent to the meridian at the point where they intersect.

Each quadrilateral of projection preserves its spheriodal area, but its two diagonals become unequal, one increasing and the other diminishing, as we go from the centre to the corners of the map, the inequality being greatest at the east and west polar corners. The application of this method of projection to the construction of the map of the State, will be shown under the head of "Drawing."

In this brief outline of the principles upon which the survey is conducted, it is seen that the basis of operations is a general preliminary examination or reconnaissance of the whole State.

GENERAL RECONNAISSANCE.

Geographical Position and Extent.

The State of New Jersey lies between the parallels of 41 deg. 20 min., and 38 deg. 55 min. 50 sec. north latitude, and the meridians 73 deg. 54 min. 10 sec. and 75 deg. 34 min. 15 sec. longitude west from Greenwich. It occupies a peninsulated position with respect to the State of New York, which bounds it on the north, and from which it is separated by an artificial line running from the point where the parallel of 41 deg. intersects the Hudson River, to the point where the parallel of 41 deg. 20 min. intersects the Delaware River. This line is 48.5 miles in length. On the east the boundary line follows the Hudson river until it empties into the Bay of New York; thence it fol-

lows the strait which separates the State from Staten Island. The remainder of the eastern and south-eastern boundaries is formed by the Atlantic Ocean. The Delaware river forms the western and south-western boundary, seperating the State from Pennsylvania and Delaware. The total area contained is 7,750.93 square miles, being 4,960,595.20 acres, of which 1,767,991 acres are improved, leaving a residue of 3,192,604.20 acres unimproved land. The total value of the farm land is $120,237,511.

PHYSICAL FEATURES.

The elevated portions of any country form the key to its topography. The hills and mountain ranges furnish the sources, while they direct the courses of the rivulets and the rivers. By their disintegration they form the plains and furnish the soil of the valleys. By them the climate is in a great measure determined; and around their summits are nursed the clouds which bring the early and the latter rain. Hence it is, that when we would indicate the topography of a country we go first to its mountain ranges; although it is difficult to form a just conception of these great features when the description is limited by political divisions.

The most elevated, most distinctly marked, and most clearly developed mountain range in the State of New Jersey, is that called the Blue Mountains. Entering near the initial point of the northwestern boundary, on a base of three miles, and with an elevation of 1,400 feet, it takes a southwesterly direction, widening at the base, but maintaining the same average height, for a distance of 15 miles, when it becomes six miles in width. Then it begins to contract, and finally leaves the State at the Delaware Water Gap, with a width of but half a mile, and an elevation of 1,500 feet, having an entire length in the State of 25 miles, with a remarkable uniformity of elevation. The greatest depression is at Culver's Gap, where it is 800 feet in height. Between the foot of the western slope and the

Delaware river, is a valley averaging one mile in width. This valley is drained by the Flatkill, a stream which runs through nearly its entire length in a southerly direction, parallel to the Delaware, being fed on its way by an infinite number of smaller streams, which serve the double purpose of irrigation and drainage. East of the Blue Mountni, and contiguous to it, lies a broad and fertile valley, known as the Kittating valley, extending from the northern boundary in a southwesterly direction, parallel to the Blue Mountains, through the counties of Sussex and Warren, to the Delaware river, being about forty miles long and ten broad. It is broken, through its entire extent, by a succession of low rounded hills, which have a culminating point about fifteen miles from the northern boundary —causing the rainage of the southern portion to flow towards the Delaware, and that of the northern portion to flow in the opposite direction, through the State of New York, towards the Hudson.

The Paulins Kill drains the southern part, and the Walkill the northern. Both streams are fed by numerous small lakes and ponds, whose basins are high up in the mountain ranges which bound the valley. So extensive are these reservoirs, that for a considerable portion of the year the Wallkill overflows its banks, inundating the country which it ought to drain, and destroying the fertility of a large tract of country which would otherwise be smiling fields. The next marked topographical feature is the continuation of the Highlands of New York, which enter the State in the same general direction as the Blue Mountains, but without its continuous aspect. This range consists of a succession of parallel ridges, intersected by occasional narrow valleys, but all following the same general direction northeast by southwest. These ridges have different names in the different localities where their features appear more marked, yet they form a connected whole, whose base in the northern boundary is about twenty-five miles, gradually narrowing to the south, being about ten miles wide at the Delaware.

Within this range lie several large and beautiful lakes, and numerous small ponds. A thousand mountain streams have here their source, and uniting, form the principal rivers of the State.

The Raritan river rises here, and running in an easterly direction, gathering on its way from every hill its spring, and from every valley its drainage, it becomes at New Brunswick, fifteen miles from its mouth, a navigable river, and empties through a broad arm into the Atlantic ocean, having a total length of seventy-two miles.

The Passaic, seventy miles in length, rises here, and empties into Newark Bay, and thence into the Atlantic.

The Hackensack, forty miles in length, rises in the same range, although not in the State, emptying also into Newark Bay.

Besides these rivers, the numerous valleys which intervene between the ridges have all their drainage streams.

The Pequest, thirty miles in length, emptying into the Delaware, is a bold and rapid stream, affords abundance of water-power, and drains a fine valley.

The Musconetcong river is the outlet of Lake Hopatcong, which lies almost in the heart of the range. This lake is five and a half miles in length, and one and a half miles wide, containing nearly four and a half square miles of water, or about two thousand five hundred acres. It is now used as the feeder of the Morris Canal. The Musconetcong is forty miles in length, flowing in nearly a straight line in a southwest direction, through a deep and narrow valley. It has a large volume of water, and gives motion to a number of mills.

There are many other streams, draining smaller valleys between these ridges, generally branches of either the Raritan or Passaic.

Next to the chain of the Highlands, on the east lies a broad, slightly elevated and slightly undulating plateau, extending

over a large area, from the northern boundary to the Delaware, with an average width of twenty miles. The surface of this plateau is broken by a succession of narrow, abrupt ridges, which traverse it in a northeasterly and southwesterly direction. These ridges are so much higher than the surrounding country, as to afford fine points for observation and for trigonometrical stations. This plateau terminates in the southeast at the narrowest part of the State, on a line drawn from Amboy to Trenton, which line was at one time the shore of the sea. The remainder of the State below this line, and as far as Cape May, is almost a level plane. A transverse line of gentle elevation divides it sufficiently to cause a portion of its drainage to flow towards the Delaware, and another towards the Atlantic. The streams, of which there are a great number flowing in both directions from the summit level, have so slight a descent, and a current so sluggish, that in many places they may be almost regarded as a succession of swamps and ponds. The whole character of the country forms a striking contrast to the other portions of the State.

The latter came into existence amid the convulsive throes of nature which followed the early affinity of matter. The former, born of the ocean at a calmer period, seems, in its gentle uniformity, to reflect the eternal lullaby of the waves which ushered it into existence. More than once, since it arose from the water, this area has sought its native element; rising for a period to court the smiles of the sun, then dipping with its green vesture into the sea, seeming indications on the bosom of the earth of the pulsations of the great heart within it.

Nearly the whole of this extensive area is covered with a dense forest, rendering it a matter of impossibility to obtain a view of the surrounding country, even from the highest of the few hills which appear upon the surface.

There is one marked feature connected with the topography of this portion of the State. From near Cape May, the extreme southern point, there extends along the coast, for a distance of

one hundred miles, a sheet of water separated from the sea by a narrow strip of sand-beach, and communicating with it by openings across this beach at several different points along its length. The action of the winds and waves are constantly producing changes, both with regard to the beach itself and the openings through it; still the interior channel remains constantly open, and is used as a means of commercial communication between the towns upon the coast. Certain observations connected with the importance and improvement of this channel, but which do not, from their nature, pertain to a general reconnaissance, will be given in a future report.

This rapid glance at the physical features of the State, while it indicates their marked peculiarity, will serve at the same time as a guide in following the detailed operations of the Geodetic and Topographical parties.

ARTIFICIAL FEATURES.

Internal Improvements.

The position occupied by the State of New Jersey, with reference to the large and thickly populated States of New York and Pennsylvania, the peculiar advantages derived from its shores being watered by two of the finest rivers in the United States, and especially its position with reference to the harbor of New York, all combined to call the early attention of its citizens to the value and necessity of artificial means of communication.

Accordingly, we see projected and carried out, a system of railways and canals, which, while they have added materially to the wealth of the State, have also conferred great benefit upon the adjoining States, and upon the country at large. It has been the policy of the State, instead of attempting these internal improvements by the State Government, thereby opening an avenue by which its finances might become embarrassed, and the credit of the State endangered, to confer such privileges upon incorporated companies as to induce private enterprise, with private

capital, to undertake these public works. The result is, that the State has a revenue without taxation, and a treasury free from debt, while railroads and canals intersect the country in every direction.

The following statement exhibits the general nature and extent of the internal improvements of the State. It is not as complete as would be desirable; still there are, it is presumed, no material errors.

CANALS.

Delaware and Raritan Canal.

This important work commences at New Brunswick, the head of navigation of Raritan river, and extends to Bordentown, where it enters the Delaware river, being forty-three miles in length. It is seventy-five feet wide at the surface, forty-seven feet wide at the bottom, and nine feet deep.

There are seven locks at each end, each two hundred and twenty feet long and twenty-four feet wide, admitting the transit of boats of five hundred tons burden. The canal is supplied with water by a feeder extending twenty-two miles above Trenton. It connects with the Delaware division of the Pennsylvania Canal, and is at present the principal avenue through which New York is supplied with coal. It also commands a large amount of freight between New York and Philadelphia, and is navigated by regular lines of propellers moving between the two cities.

The annual transportation of coal is over one million tons; of grain over one million bushels; and about two hundred thousand tons of general merchandise.

Cost of the canal - - - - -	$3,707,915 90
Receipts for the year 1854 - - -	474,740 39
Expenses " " - - -	171,753 98
Earnings " " - - -	303,186 41

The Morris Canal.

This canal extends, by a circuitous route, from the Hudson river at Jersey City to the Delaware river at Philipsburg, opposite Easton, where it connects with the Lehigh Canal of Pennsylvania. The boats are carried over the chain of the Highlands by means of a series of locks and inclined planes. This canal was projected for the purpose of opening a means of communication between the coal fields of Pennsylvania and the large mineral deposits of the northern portion of the State, and between the latter and the New York market. It is one hundred and one miles and three quarters in length, thirty-two feet wide at the top, twenty-two feet at the bottom, and four feet deep.

The locks are seventy-five feet in length, and nine feet wide. Their limited capacity prevent the canal from transporting a large amount of coal, but it has been the means of opening to market a vast amount of mineral wealth, and may be regarded as a source of great vitality to the northern counties of the State; while its conception and execution bear evidence of a skill and perseverance which has not been without its effect upon the State at large.

RAILROADS.

Camden and Amboy Railroad.

This was the first railroad built in the State. It extends from Amboy, on Raritan Bay, to Camden, on the Delaware, opposite Philadelphia. It connects with New York by steamboat, and with Philadelphia by a ferry. It is ninety miles in length, and has a branch road from Camden to New Brunswick, where it meets the New Jersey Railroad. Upon it, in connection with the New Jersey Railroad, is thrown not only all the travel between the two largest cities in the Union, but between the two great divisions of the country.

As might be expected from such relations, it commands an immense amount of passenger-traffic, and ranks among the

most successful and productive works of the kind. It is much more important as a route of travel than commerce, since the Delaware and Raritan Canal, which has the same general direction and connections is a better medium for heavy transportation.

Cost of the road - - - - - -	$4,763,184 58
Receipts for the year 1854 - - -	1,682,486 23
Expenses " " " - - -	1,130,092 10
Earnings " " " - - -	552,457 13

New Jersey Railroad.

The New Jersey Railroad extends from Jersey City to New Brunswick, thirty-one miles, passing through the large manufacturing towns of Newark and Rahway. At Elizabeth City it connects with the New Jersey Central Railroad, and thence with the great coal basin of Pennsylvania. This road is of great local importance, but its chief traffic is in connection with the Camden and Amboy branch road from New Brunswick to Camden, by which it is extended to Philadelphia, making a total length of eighty-seven miles.

Cost of the road - - - - -	$3,239,592 51
Receipts for the year 1854 - - -	824,032 93
Expenses " " " - - -	383,585 21
Nett earnings " " - - -	440,447 72

Central Railroad of New Jersey.

The Central Railroad of New Jersey ranks high in prospective importance, while its local value is now very great. It extends from Elizabeth Port, on Newark Bay, to Phillipsburg, on the Delaware, opposite Easton, being sixty-three miles in length, passing through the most fertile portions of the counties of Essex, Somerset, Hunterdon and Warren. At Elizabeth City it connects with steamboat to New York. At New Hampton it connects with the Warren Railroad, extending to the Water Gap, where it meets the Delaware, Lackawanna and Western

Railroad of Pennsylvania. At Easton it forms a connection with the Lehigh Valley Railroad, and thence with the Dauphin and Susquehanna, and the Catawissa Railroads; all extending into the heart of the great coal basin of Pennsylvania. This road has now a double track, and the company has contracted to deliver in New York the coming year five hundred thousand tons of coal. It is contemplated to extend this road to Jersey City, crossing Newark Bay at its entrance.

Cost of the road - - - - -	$2,805,683 71
Receipts for the year 1854 - - -	378,145 33
Expenses " " " - - -	197,349 43
Nett earnings " " - - -	180,795 90

Morris and Essex Railroad.

This is an important road, having characteristics similar to the Central road. It extends from Newark to Hackettstown, a distance of fifty-three miles, with a proposed extension to the Water Gap.

Its cars run over the rails of the New Jersey Railroad from Newark to New York. From Hackettstown it is intended to extend the work to a point on the Delaware river, opposite the Water Gap, where it will connect with roads leading into the Lackawanna valley, thus affording another outlet from the great coal basin to the seat of commerce. The local traffic of this road is rapidly increasing, which fact may be stated for all roads in the State. When the extension of this road is completed, it will be one of the most important coal roads in the country, and it will also have a powerful effect upon the developement of the rich mineral districts through which it passes.

Cost of the road - - - - -	$1,549,621 68
Receipts for the year 1854 - - -	233,595 64
Expenses " " " - - -	134,216 33
Nett earnings " " - - -	99,379 31

Belvidere Delaware Railroad.

This road extends from Trenton along the Delaware river to Belvidere, in the county of Warren. It is an important road as an auxiliary communication between Philadelphia and the north-eastern coal basin of Pennsylvania. At Lambertville it connects with the Flemington Railroad to Flemington, which is now used as a branch of this road. At Phillipsburg it intersects and connects with the Central Railroad.

The total length of the road, including the branch to Flemington, is seventy-five miles. At Trenton it connects with the Camden and Amboy, and the Philadelphia and Trenton Railroads. This road has not been long enough in operation to form a correct estimate of its work.

The cost of it has been upwards of $2,500,000.

Warren Railroad.

The Warren Railroad extends from the Delaware river, at the Water Gap, in the county of Warren, to the Central Railroad of New Jersey, near New Hampton, having a branch to Belvidere. It connects at the Delaware river with the Delaware, Lackawanna and Western Railroad, of Pennsylvania. The branch road connects with the Belvidere and Delaware Railroad at or near Belvidere. This road is not yet completed. When it is done, the Central road will have three connections with the coal basin.

A correct estimate cannot yet be formed of its costs or results.

Flemington Railroad.

The Flemington Railroad, from Lambertville to Flemington, in the county of Hunterdon, is twelve miles in length, and is an agricultural road, worked as a branch of the Belvidere Delaware Railroad.

Cost of the road - - - - - $211,281 63

Freehold and Jamesburg Railroad.

An agricultural road in the county of Monmouth. It extends from Freehold, the county town, to Jamesburg, where it connects with the Camden and Amboy road.

It is eleven miles in length, and cost $163,743 91.

Burlington and Mount Holly Railroad.

A branch of the Camden and Amboy road from Burlington to Mount Holly, in the county of Burlington.

It is six miles in length, and cost $163,763 91.

Sussex Mine Railroad.

This road extends from Newton to Waterloo, in the county of Sussex. It is twelve miles long, connecting with the Morris and Essex Railroad at Waterloo. It is an agricultural road, used principally for the transportation of iron; cost about $300,000.

Millstone and New Brunswick Railroad.

This is an agricultural road from Millstone to New Brunswick, in the county of Somerset, six and sixty-three hundredths miles in length, and cost $106,636 22.

Camden and Atlantic Railroad.

This is an agricultural road, extending from Camden, on the Delaware, to Atlantic City, on the Atlantic Ocean, passing through the central portion of the counties of Camden and Atlantic. This road depends for its success upon the cultivation and development of a large area of land hitherto a dense forest. The trees are gradually disappearing under the hands of the woodman, and a few years will work an entire change in the whole face of the country. It is also anticipated that this will form a connection with a new route for transportation, between New York and Philadelphia. Atlantic City, one of the terminii of the road, is a place of resort in the summer season, where is found excellent sea bathing. The road is sixty miles in length, and cost $1,499,185 91.

Paterson and Hudson River Railroad,

From Paterson to Jersey City, is seventeen miles in length; cost $680,000, and is leased to the Erie Railroad Company.

Paterson and Ramapo Railroad,

From Paterson to Ramapo, near the State line, is the continuation of the Paterson and Hudson River Railroad. It is seventeen miles in length, cost $350,000, and is leased to the Erie Railroad Company.

New York and Erie Railroad.

This road having leased the two last mentioned roads, has increased the gauge, and run its passenger cars to Jersey City, instead of Piermont as heretofore.

Besides the railroads which have been enumerated, there are a large number which have been projected in different parts of the State, some of which will undoubtedly be completed within a short period. There are but three which from their importance call for a special notice in the present report.

Delaware and Hudson River Railroad.

This road is projected by the Pennsylvania Coal Company, who are the owners of a very large tract of land in the Pennsylvania Coal Basin. The coal from the mines has been and is now brought to market by the way of the Delaware and Hudson Canal, and being limited by the capacity of the canal, the company is able to bring to market neither the amount they are able to mine, nor an amount sufficient to supply the demand. A strong necessity to obtain some other avenue to market has thus been forced upon them. The mode by which they propose to transport their coal, while it is novel and interesting in its design, would in the event of its execution, be of very great value to the northern portion of the State.

It is well known, and more clearly shown in the topographical

description of the State, that while the territory of New Jersey is the shortest route to the seaboard from the coal basin, the value of distance is lost from the fact that almost insurmountable barriers obstruct a direct communication. The construction of the Morris Canal was an effort to obviate this difficulty, but for want of capacity it has not accomplished its object. On the other hand, the New York and Erie Railroad, and the Central Railroad of New Jersey, by going around these obstacles have sought to avoid the difficulty.

The plan proposed by the Pennsylvania Coal Company is what is called the Gravity road. It seeks to make the obstacles themselves useful while surmounting them, that is to say, by means of a series of inclined planes, with short ascents and long descents and stationary engines at the summit of each plane. The cars being raised up the short ascent by means of the engines, are suffered to descend the slope by force of gravity. The route proposed is to ascend to an elevated point on the Blue Mountains, at the Walpack Bend, from there alternately descending and ascending along the western slope, until it reaches Culver's Gap; from thence it descends into and crosses the Kittatinny valley, then ascending the Hamburg mountain to Snufftown, it descends in one long plane to the Hudson River. It is seen that this route passes through the very heart of the great iron region of the State, and should the project be carried into successful execution, the hum of busy industry will replace the silence of these mountains and valleys.

The West Jersey Railroad.

In this project is embraced several different routes, having for their object the developement of the south-western portion of the State, or the area included principally within the limits of the counties of Camden, Gloucester, Salem, Cumberland and Cape May.

These counties are, from their position, off from the general line

of travel, and the market is reached solely by steamboat communication on the Delaware, requiring all the produce to be transported to the steamboat landings.

A railroad with a central location would be of great benefit, not only as a means of transportation for the present products, but also by increasing the facilities, to increase the products. The different routes which have been surveyed to this end are shown on the sketch.

Delaware and Raritan Bay Railroad.

This road is a project for materially shortening time and distance between the northern and southern sections of the Union. The eastern portions of the States of New Jersey, Delaware and Maryland, on account of the uniformly level nature of the surface, offer peculiar facilities for the construction of railroads. The obstacles to a connected line of road are the bays which intervene. It is proposed, by means of a regular connection between boats and cars, to form a direct line of connection between New York and Norfolk. The part of the line which lies in New Jersey is laid down on the map.

As far as this State is concerned, it must be of great benefit to it as a means of developing a large area of land now lying unproductive.

Camden, Pemberton and Freehold Railroad.

A company has been chartered for the purpose of constructing a railroad between the points indicated in the above title, and the surveys for location have been made. A glance at the accompanying sketch will show at once that it passes through a district yet unvisited by any line of railroad. In addition to this, it is a new district, with its soil still covered to a great extent with a primitive forest. As a means of agricultural develepement, the road possesses striking features, and although the present population along the line proposed is not very great, yet there is no doubt that its completion would produce an entire

change in the whole face of the country, and open for cultivation an extensive area, which as it now is, might as well be in the far west.

It is proposed in the final report to give a full and illustrated description of every work of public interest, that may be at that time completed within the limits of the State. At the present date the total length of completed railway in the State is five hundred and four miles, costing about twenty millions of dollars.

FIELD WORK.

Organization of parties.

There is no duty connected with the survey more difficult or delicate than the organization of the different parties. Their duties are of such a nature as to require the greatest skill, combined with the highest integrity. As the parties are broken up at the close of the season, we are deprived of the advantages which would be derived from their increased proficiency. Much depends, therefore, upon judgment in selecting proper persons for the different positions, and there is always a chance of being deceived, until their character and capacity have been tested in the field. Fortunately, but few instances have occurred in which the persons were not what they professed to be, and these were not such as to result in any material detriment to the survey.

Both the triangulation and topographical parties are composed permanently of a chief, a first and a second assistant. When circumstances require it, one or more temporary assistants are employed. The chief has the immediate charge of the party, and upon him depends its good conduct, and the accuracy of the work. He keeps a daily journal of everything connected with the survey which transpires in his party, and transmits a weekly abstract of the same to the office. The first assistant gives to the chief such assistance as he may require in the details of the work. He also keeps a record of all the information he may be able to obtain concerning the character of the

soil and mineral deposits; communicating semi-monthly all of the items connected with the geology of the district in which the party may be located, which he may deem of sufficient importance. These reports are of material assistance to the Geologist in going over the ground. The duties of the second assistant are more manual than otherwise.

As soon as each plane table sheet is completed, it is turned into the office, accompanied with a manual containing the numbers corresponding to the house on the sheet, and the names of the occupants of each house, the amount of cultivated and uncultivated land in each farm, the depth of every well, and the soil passed through in digging it, the three crops which have the highest average, and if any what mill or mineral property is being worked or developed by any person whose name is in the manual.

This furnishes a complete index to the present condition of every section of the State, upon which reliable estimates and calculations may be based.

TRIANGULATION.

In the examination of the physical features of the State we have seen that while in the northern division we have two distinct mountain ranges, besides many isolated points of elevation, the southern division presents scarcely a single prominent point, and therefore that a triangulation of the latter can only be accomplished by erecting stations at the necessary points. It follows that the triangulation would be first pushed towards the north, more especially since the Coast Survey, in prosecuting its hydrography, has completed a secondary triangulation of the Atlantic coast, and the Delaware river as far as Trenton, thus giving the plane-table parties in the southern counties a sufficient number of geographical points to enable them to prosecute their work without chance of error.

As was stated in the report of last year, the coast of the Uni-

ted States, for the purpose of the geodetic survey, has been divided into eleven sections, in each of which a base line from five to ten miles in length has been measured. The coast of New Jersey is included in the second of these sections, the base of which is on Fire Island, which adjoins the coast of Long Island. The primary triangulation extends across the State, from Amboy to Trenton, and down the Delaware river. The necessity for measuring a base-line in the State is thus obviated, since a side of this primary triangulation can be assumed as our base of operations. The side which has been selected, is the line forming Mount Rose station, in the county of Mercer, with Springfield station in the county of Essex. The length of the line is twenty-nine miles and forty-three hundredths. The latitude of Mount Rose is 40 deg. 22 min., and its longitude 74 deg. 43 min. The latitude of Springfield is 40 deg. 41 min., and its longitude 74 deg. 21 min. This line occupies a central position, and is very favorably situated for the continuation of the triangulation, especially towards the north. The many prominent points there found have afforded us a choice of positions, and we have thus been able to establish such stations as to give us well conditioned triangles, which we have extended to the Delaware river, and the northern boundary, one station being in the State of New York. The number of stations occupied is 25; the number of observations made is 460.

The whole net-work, as far as has been completed, including that of the Coast Survey, is shown in the accompanying sketch. The heights of all the stations occupied have been determined by means of a barometer. A table of all the geographical positions which have been determined in the State is annexed, for reference in local surveys. The triangulation party has been under the direction of Mr. Fuellhart, who has exhibited throughout a commendable activity.

PLANE TABLE WORK.

The provisions of the act authorizing the survey require that each county shall be completed separately, consequently the operations of each plane table party have been limited by the county divisions.

Operations have been carried on during the season in nine counties, to wit: Sussex, Warren, Morris, Hudson, Monmouth, Salem, Cumberland, Cape May, and Atlantic. Of these, Sussex and Cape May are completed—while Salem, Morris, Monmouth, and Warren are nearly so—with material progress in the others. The following detailed account exhibits the progress of the work in each county:

County of Sussex.

The field-work of a large portion of this county was completed during the latter portion of the past year.

This being the first work done in the survey, and done, in a great measure, with the assistance of young men, who, to say the least, were unpracticed in their duties, it is natural to suppose that a certain degree of revision was necessary to insure the accuracy of their work. This revision has been made, and the topography of the county completed, and it is presumed that no material errors will be found in it.

The plane table party assigned to duty in this county took the field on the 3d day of April, under the charge of Mr. Charles A. Heering; Mr. T. B. Brooks, first assistant. Until the 1st of June their operations were greatly impeded, by the extreme quantity of rain which fell in the months of April and May; nevertheless the party, by their industry and strict attention to their duties, were enabled to complete the field-work of the county on the 1st of September. Mr. Heering was transferred, on the 1st of August, to the Morris County party, and his place taken by T. Benton Brooks, who applied himself so closely to his duties as to injure his health, and render it necessary for him to proceed

to the South. He anticipates joining, in the spring, with renewed health.

The map of the whole county of Sussex is now drawn, and submitted with the report.

County of Morris.

A plane table party took the field in this county on the 1st day of May, under the direction of Mr. Fuellhart; Mr. R. W. Patterson, first assistant.

From that time until the 1st of August, when he was relieved from the charge of the party by Mr. Heering, Mr. Fuellhart turned into the office two plane table sheets, each containing one hundred square miles, exhibiting a large amount of labor. Mr. Heering remained in charge of the party until the first of November, and completed about one hundred and thirty square miles. On the above date the field-work of Morris County was suspended for the season, and Mr. Heering was transferred to the charge of a party in Cumberland County. The party will resume the field in this county early in the spring, and the map will be completed by midsummer.

County of Salem.

While the absence of mountains, and even of hills, in the southern portion of the State, relieves the topographer from a great deal of labor in respect to contour lines, nevertheless these very features of the surface is an impediment in the way of rapid progress. The want of elevated points compels him to increase the number of his stations, and the forests intercept the view entirely. The streams, also, in a flat country, especially near the sea, are very tortuous, and as a general thing are too deep to be forded—and there being but few bridges, a great deal of time is lost in simply going from one point to another.

These remarks apply to all the work done in the lower counties, more particularly, however, to the county of Salem. The party assigned to do duty in this county, was placed in the field

on the twentieth of April, and withdrawn on the twenty-fourth of October. About one hundred and twenty-five square miles of topography was completed, which, with the topography accomplished by the Coast Survey, and drawn on the map of Delaware Bay, leaves a comparatively small portion of the county remaining. The whole county will be completed early in the ensuing season.

County of Monmouth.

The party took the field in this county on the 1st day of May, under the charge of Mr. G. Bechtle. As this county borders upon New York Harbor, a considerable portion of its topography has been completed, and engraved upon the large maps of the harbor, printed by the Coast Survey.

The party commenced operations on a line drawn through Red Bank and Shrewsbury, and worked into the interior. About one hundred and forty-five square miles of topography was completed, in addition to that of the Coast Survey, making a total of about two hundred and fifty square miles. The extreme accuracy of detail measurement maintained by the chief of this party, and which is not essential or practicable in a map of this nature, caused a slower progress than would otherwise have been accomplished. Mr. Bechtle has exhibited, throughout the season, a praiseworthy degree of industry and conscientiousness. Mr. I. M. Bunnell was the first assistant of this party during the greater part of the season.

County of Hudson.

A party was placed in the field in this country on the twenty-sixth of April, but in consequence of the fact that the commissioners on harbor encroachments, appointed by the Governor of the State of New York, having decided to make a re-survey of the harbor and adjoining lands, which survey was commenced, under the direction of the Superintendent of the Coast Survey, it was deemed advisable to suspend operations in this county, and

withdraw the party until such re-survey was completed, when we shall have the benefit of it.

County of Warren.

On being withdrawn from the county of Hudson, the plane table party, under the charge of Mr. G. G. Friedlein, as chief, with Mr. Charles E. Baldwin as first assistant, was transferred to the county of Warren. They remained in the field until the 6th of November. During this time the most difficult part of the topography of the county was completed, embracing the northern portion, from the county of Morris to the Delaware River, and north of the line from Hackettstown to the Delaware Water Gap. The party worked with due diligence, and the plane table sheets, as well as the field-notes, exhibit great care and accuracy of detail.

County of Cape May.

The party took the field in this county on the 20th of August, Mr. V. E. Koerber, chief of the party, and Mr. O. Dietz first assistant. The very peculiar nature of this county being almost a perfect level, and covered for the most part with a dense growth of trees, through which an infinite number of roads ramify themselves in every direction, rendered the work here a matter of patient industry and tedious labor. No elevated points present themselves upon which the topographer can establish himself, and determine his position. He must needs follow every road with a chain and compass, oftentimes having his way intersected with interminable swamps, and for miles and miles no human habitation meet his eye. The survey of the county is now completed, and the party is engaged in the county of Atlantic.

County of Cuumberland.

This party, under the charge of Mr. Charles A. Heering, with Mr. I. M. Bonnell as first assistant, was transferred to this county from Morris. On the first of November they established

themselves upon points of the secondary triangulation of the Coast Survey, in the vicinity of Greenwich, and are working in the direction of the interior. One plane table sheet is about completed. Should the weather prove favorable, they will be able to turn into the office the greater portion of the county by spring.

County of Atlantic.

The party operating in this county is under the direction of Mr. V. E. Koerber, and is the same party which completed the survey of the county of Cape May.

Their first plane table sheet in this county is just commenced, yet judging from the fidelity and skill displayed by the party thus far, we may look for their completion of the survey of the county in a very reasonable time.

TRUE MERIDIAN LINES.

By an amendment to the bill making an appropriation for the continuation of the survey, it was made incumbent on the persons in charge of the work to establish several lines in different portions of the State, indicating the direction of the true meridian, for the purpose of furnishing to local surveyors a means of ascertaining the variation of the compass in different localities at different times.

Newark, Trenton, and Camden, were designated as the points for locating these lines. It is the intention, however, to establish the meridian, if possible, in every county. Reconnaissance for selecting favorable positions has been made at Paterson, Trenton, and a preliminary line located in Newark; also some of the monuments have been prepared. Owing, however, to the non-receipt of an instrument to be used for the purpose, which it was expected would be loaned by the Coast Survey, the lines have not yet been located. Early in the ensuing season, when the demand for their instruments will not be so great in the Coast Survey office, it is anticipated that all these lines will be determined.

OFFICE WORK.

Drawing.

In the drawing division, work was commenced simultaneously with the field operations. In a proper organization of the work, the projection of the geodetic net work forms the basis, not only for the drawing of the maps, but also for the plane table sheets. This will be first referred to.

It has been stated that the conic projection has been selected for the map of the State, as being that one which afforded advantages over all others. This method requiring a central meridian, and a central parallel, we have selected Princeton as the central point. Having drawn the principal meridian and parallel, and constructed the other meridians and parallels according to known principles, which have been referred to, we divide each quadrilateral of projection into smaller quadrilaterals, corresponding to the size of the plane table sheets; these are referable by the co-ordinates of their corners to the central point. And by having on each sheet at least three trigonometrical stations, we have no difficulty in locating the precise position of the sheet in the field. In the desire to accomplish the topography of certain district for the use of the Geologist, the system has not been strictly adhered to, but the necessity for a deviation from it no longer exists.

In addition to plotting the geodetic net, calculating and plotting the triangulation, the draughtsmen have completed the maps of the counties of Sussex and Cape May, besides furnishing tracings of nearly all of the plane table sheets to the geologists, and supplying enlarged copies of the Coast Survey work to the different plane table parties.

The small scale upon which the last year's field work in the county of Sussex was done, rendered the drawing of the map of the county very difficult. The patience and industry which has been shown in its execution are worthy of praise.

Mr. J. H. Pieper, principal draughtsman, has been unremitting in the discharge of his duties, giving to the work a great deal of time and attention not called for by the terms of his employment.

Engraving.

Deeming it proper that the character of every part of the work should be in keeping, the work of engraving on copper was commenced in the month of August, with the map of the county of Sussex, on account of the drawing of that county being completed. The map will be in four plates, two of which are nearly finished. The execution of the work thus far has fully met the expectations that were formed, both as to beauty of finish and economy, for it is seen that if one-half the prices usually paid for the most ordinary maps is fixed for these maps, the cost of engraving and printing will be defrayed. The plates can be electrotyped at the Coast Survey office in Washington, if it is deemed advisable, or the maps may be printed from lithographic transfer plates.

CONCLUSION.

In concluding the report, a brief reference should be made to one or two facts, which have been mentioned for the purpose of pointing out more distinctly their bearing upon the general welfare of the State.

It appears that out of 4,960,595 acres of land included within the limits of the State, there are 3,192,604 acres entirely uncultivated. Yet there are in New Jersey no deserts, nor dismal swamps, where the labor of man would be exhausted in vain efforts to redeem nature for his wants. No charge has ever been made that the people of New Jersey are deficient in energy, in intelligence, or in skill. Still there must be some reason why so much tillable land should remain undisturbed by the plough of the husbandman, while millions of non-producers almost within sight stand ready to produce every grain that is offered to

them. The reason why it is so is sufficiently obvious, but why it should remain so is not so plain.

Why it is so, arises from the fact that the early settlers of every country establish themselves along the rivers and smaller streams, where a little toil is remunerated by an abundant harvest. This soil, however, becomes in time exhausted by constant tillage, and the farmer finds that he cannot, from his own resources, renew it, and that he must purchase foreign fertilizers to maintain the productions of his farm. His profits become diminished in consequence, and he or his sons begin to think of seeking a new sphere where their labor will meet with a better reward. Now, we would ask if those lands which are *not* on the rivers and streams, and which are *not* as productive *at first*, as the more recent alluvials, cannot be made as productive, with a less amount of fertilizing matter, and at a less cost, than is now required to fructify the exhausted lands? This is a great question, which, in view of the proximity of the market, in view of the increasing demand, and in view of the great amount of scientific skill which can now be brought to the aid of agriculture, should engage the earnest attention of the farmers of the State.

Another point which should be referred to, is the obvious connection between the internal improvements and physical features. One glance is sufficient to show that to the mineral deposits of the State and Pennsylvania, are due, with one exception, all of the main lines of canal and railway within the State. Extensive as they are, may it not be possible that they are but a foreshadowing of what will be? Is there not space enough, and material enough, for a Birmingham on Morris Plains, or for a Manchester in the Kittatinny Valley?

The immense amount of water power now almost wasted on a thousand insignificant saw mills, in the northern part of the State, needs only enterprise to make its value known and felt. Nothing but enterprise has built up, upon the island of Manhattan, a splendid city of over half a million of souls, while the Jer-

sey shore, having more commercial facilities, is a comparative suburb.

It is the object of this survey to develop the resources of the State in such a manner, that every citizen may be as familiar with every portion, as he is with his own immediate neighborhood, and that the people of the State, from a comprehensive sense of the value of these resources may be incited to more vigorous effort.

It is not alone from an advantageous geographical position—a favorable topographical configuration—a genial climate—a fertile soil—or mineral riches—that a State derives its wealth and power; they come from the active energy, intelligence and industry of its people, seeking, under salutary laws, and free institutions, a higher state of development. While ignorance and indolence would in effect reduce the State to comparative poverty, well directed industry adds new beauty to its fair face, and increases the wealth of its prosperous people.

EGBERT L. VIELE,
State Topographical Engineer.

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REPORT

ON THE

GEOLOGICAL DEPARTMENT.

SOUTHERN DIVISION OF THE STATE.

TO DR. WM. KITCHELL, *Superintendent of the Geological Survey of the State of New Jersey:*

SIR:

I herewith submit the second Annual Report on the geological survey of the Southern Division of the State.

Respectfully yours,

GEO. H. COOK,
Assistant Geologist.

New Brunswick, Dec. 29, 1855.

REPORT

ON THE GEOLOGY OF THE SOUTHERN DIVISION.

The field-work in the geological survey of the southern division of New Jersey, has been chiefly confined to the counties of Monmouth, Salem, and Cape May. Examinations of a somewhat general character have also been made in the counties of Cumberland, Gloucester, Camden, Burlington, Ocean, and Middlesex.

It will be convenient to arrange the material of the report under the following heads:

1. Recapitulation of last year's report.
2. Further examinations in the work commenced last year.
3. Examination of other geological formations.
4. Chemical examinations, and practical suggestions on them.
5. Progress of the survey in different counties.

Cedar swamps.

Gravel bricks.

1. *Recapitulation of last year's work.*

In the report of last year it was stated that the southern division of New Jersey, as divided for the purposes of the geological survey, had, for its northern boundary, a line running in a southwesterly direction from Staten Island Sound, near Elizabeth Port, to the Delaware river a little below Trenton—following generally the southeastern margin of the red sandstone and shale which is so conspicuous a feature of the central part of the State. All of the State south of this line is included in the southern division.

The whole of this district is remarkable for its low and generally level surface, and for the entire lack of rock formations. Its geological structure, however, is very regular and uniform. With some exceptions, which will be mentioned hereafter, it is made up of successive strata, which stretch across the State from the northeast towards the southwest, and descend beneath the surface towards the southeast; so that, as we pass from the north, or division line, across the State in a southeasterly direction, the strata are crossed in succession, the lowest first, then the next above, and so on in order to the highest. In this way the light colored clays, including the fire and potter's clays, are first crossed; then the black and chocolate colored astringent clays; then the several beds of greensand marl, with intermediate beds of sand; and lastly, the more recent beds of shell-marl, sand, clay, and gravel, which make up the southeastern part of the State.

Of the clays which are next the red sandstone, no description was attempted, except it was remarked that the upper portions of the dark clays contained more or less green-sand—the latter being found in spots and irregular streaks in the clay. The stratum containing the greensand marl was principally described from observations made upon it in the eastern part of Monmouth County, though it was known to be pretty regularly developed entirely across the State to its southwestern extremity, near Salem, in Salem County. Three distinct beds of greensand were mentioned. The first of these includes the marls which are found north of the North or Neversink river, Swimming river, and Yellow brook, and on the headwaters of South river. The second includes those found on both sides of South or Shrewsbury river, and of Hockhockson brook, and on the headwaters of some branches of Yellow brook and Manasquan river. The third includes the marls of Deal, Poplar, Shark river, and Squankum. These beds all incline towards the southeast. The first of them passes under a thick bed of reddish or yellowish

sand, which inclines the same way with the marl, and in its turn passes under the second bed of marl. Between the second and third marl beds there is a heavy bed of sand, in color and appearance much like beach sand, except that it has greensand grains scattered all through it.

The fossils in the several beds are mostly distinct, and characteristic ones are to be found in each. The first contains great numbers of large oyster shells; (*Gryphea convexa* and *Exogyra costata;*) also the *Belemnites Americanus*, *Terebratula sayii*, and *Ostrea falcata*. The second is characterized by the *Terebratula harlani*, *Gryphea convexa* and *G. vomer*, and by numerous corals. The third has many fossils not found in the other beds; some of them have not yet been described.

The material which gives name and character to these beds is in little grains about like gunpowder in size, some shade of green in color, soft, and when crushed on the nail or on paper it always leaves a green streak. This is what is commonly known as greensand, but in the district where it is found or used in New Jersey it is called marl. It is mixed with more or less of sand, clay, and lime, the latter both in the form of fine powder and in shells.

The first bed, which is perhaps thirty feet thick, presents the appearance of several distinct layers; the bottom very sandy, with some marl grains; next above this is a layer of nearly black and almost pure marl grains; then a layer of marl, containing a great many shells and much carbonate of lime in fine powder; this layer is usually some shade of blue or gray; then another much like the second; and lastly, one in which marl grains and thin, flaky shells, are quite abundant at the lower part, but as we get higher a black clay takes the place of the shells and marl grains, and at the top it is only a micaceous black clay. The marl from this bed, after exposure in heaps, is of an ash or slate color.

The bed of sand overlying this is much colored with oxide of

iron, and where it is sufficiently firm, is found to be almost full of the impressions of shells. The upper part of it is mixed with, and colored by, a greenish earth or clay.

The second marl-bed was described as in three layers; first, one of marl grains, almost free from earth or shells; then one in which the marl is mixed with numerous soft and white shells; and highest, one in which the marl grains are almost entirely wanting, and broken shells, corals, &c., with a little sand, make up the mass. In some places, this last layer is hard enough for a rock, and is burned into lime. The marl of this bed, when exposed, is a yellowish green. The sand between the second and third beds has usually been confounded with beach or surface sand, which it closely resembles.

The third bed of marl is also in three distinct layers: the lower one of green marl and clay; the second one almost entirely of a sandy, drab-colored clay; and the third of marl grains largely mixed with drab-clay, the whole having a bluish-green color. Marl from this bed, on exposure, is of a green color, intermediate to the first and second.

A few analyses of marls from the different beds were presented, in which phosphoric acid was shown to be a constituent of all the good marls; and it was also shown that those which have the best reputation as fertilizers possess the largest per centage of that substance.

Nothing was said of the formations above the marl.

2. *Further examinations in the work commenced last year.*

During the past season, the marl formation has been traced up to a considerably greater extent than before. The lowest bed which was traced from the sea shore west to the road between Freehold and Englishtown, in Monmouth County, has been followed up across the remaining part of Monmouth to Burlington County; and it has been traced entirely across Gloucester and Salem Counties to near the Delaware river. The second bed,

which had been examined only as far as Blue Ball, in Monmouth County, has been traced entirely across the counties of Monmouth, Ocean, Burlington, Camden, Gloucester, and Salem. The third has been traced from Squankum, across Ocean and Burlington counties, and to Clementon in Camden County, beyond which, after careful inquiry and examination, no trace of it has been found.

In describing the geographical position of the marl beds, advantage may be taken of their direction, or *strike*, and of their inclination, or *dip*, to define with more closeness their exact location. To ascertain the strike, two places in the same bed, and on the same level are taken, and the bearing of the straight line between them ascertained. At Red Bank, in Monmouth County, the top of the lowest bed of marl is at tide level; in the same bed, near Marshallville, in Salem county, the top of the marl is but a few feet above the same level; and at St. Georges, in Delaware, the top of the bed is also at tide level; the straight line running through these points bears S. 56 W., or N. 56 E. The bottom of the second bed is only two or three feet below tide at the north end of the bridge over Parker's Creek, near Shrewsbury, in Monmouth County; the bottom of the same bed is just above tide level, on the bank of Salem creek, at Mr. Geo. Abbott's, a mile from Salem; the line joining these is also S. 56 W. The top of the same bed is opened near Long Branch village, in Monmouth County, and at what I judge to be about the same level, in the pits of George Ward, near Swedes bridge, in Mannington township, Salem County; and the direction of line S. 56 W. In the third or highest bed, there are not yet sufficient observations made to determine its strike, but enough to make it probable, that it has the same as the others. It is to be presumed that slight variations from this direction will be observed in some instances, but generally the strike of the marl stratum may be taken at S. 56 deg. W.

The dip is ascertained by drawing lines down the slope, or

descent of the beds, at right angles to the strike, that is in a direction S. 34 deg. E., and finding the angle of inclination between these lines and horizontal ones; or else by finding how many feet these lines rise or fall to the mile. The heights of many of the marl pits in a part of Monmouth County, have been ascertained by levelling, and from these it is calculated that the dip of the first bed is not far from thirty feet to the mile. That of the second and third beds cannot yet be given with equal exactness, but it is nearly the same as the first.

At Winslow, in Camden County, an Artesian well was bored for the Winslow Glass Works, and the Hon. A. K. Hay has kindly furnished the following account of the strata passed through:

12	feet,	stiff sandy loam.
7	"	clay.
93	"	quicksand.
35	"	stiff black clay.
28	"	quicksand.
27	"	black sand.
44	"	brown sand.
33	"	black clay.
20	"	dark green marl and shells.
17	"	light greensand and marl.
316	"	whole depth.

Winslow is about twelve miles southeast of Clementon, where the nearest marl pits are opened. The elevation of Winslow or Clementon is not ascertained. Longacoming, lying between them, is 180 feet above tide, and is higher than either of the other places. The fact is interesting, as proving the descent of the marl towards the southeast for a great distance, and if the two places should be upon the same level, it would show that the rate of descent is nearly the same as in the beds, when near the surface.

As many measurements of the marl stratum as possible have been taken and recorded. There is only one section at present known in the State, where one of the marl beds can be seen in its full thickness—and that is in the Highlands on the shore of Sandy Hook bay, where the first bed can be seen with the bed of clay below, and that of sand above. At most places where marl is dug, the pits are in fields, or banks of streams, and the upper part of the marl has been changed by the action of air and moisture, so that is not recognised; and at the bottom, water, caving in of pits, or other causes, hinder the workmen so that they rarely observe the exact termination of the marl. This makes it difficult to find out the thickness of the layer. And in the pits where the ground is wet, they are generally dug and filled up the same day, so that it is difficult to get a description of the material passed through, even where the depth is ascertained.

Thickness of the first bed.

At the Highlands, on the shore of Sandy Hook bay, the following section was measured; reddish-yellow, or ferruginous sand, of great thickness, lying over the marl:

9	feet	of black, micaceous and astringent clay.
5	feet	of black clay as above, with some thin and flaky shells.
25	"	of marl, greensand; the upper part, for three or four feet, mixed with the clay over it, the rest almost free from clay, and consisting of marl grains, fine carbonate of lime, shells and a little sand.
3	"	sand and small gravel, with marl grains and shells.
42	"	total thickness.

Chocolate colored, or almost black clay, in thin layers, with seams of sand between, underlies the last mentioned layer.

At the North American Phalanx pits, on Hop brook, in Atlantic township, Monmouth County, the black clay is seen overly-

ing the marl, but not in its full thickness. The following series of specimens, obtained at the different depths mentioned, were presented by Mr. Charles Sears, President of the Association:

At 6 feet, the sample is an average, and is a micaceous clay, dark colored, and containing some thin and tender shells, and a few marl grains.
" 9 " specimen similar to the preceding, but with more marl.
" 12 " clay, with large per centage of marl grains.
" 15 " marl without clay, but with some fine carbonate of lime; bluish gray color.
" 18 " same as at 15 feet, but of a little darker color.
" 21 " same as last specimen.
" 24 " lighter colored marl than the preceding, and containing a large per centage of fine carbonate of lime.
" 28 " same as the last specimen.
" 30 " similar to the last, but a shade darker.
" 32 " more of a bottle green color, and the marl grains finer.
" 34 " same as preceding.
" 36 " same.
" 38 " same.

From 21 feet down, the specimens were obtained by boring; the boring terminated in marl.

At the pits of Wm. Hartshorne, a mile and a quarter north of Freehold, the following measurements were obtained:

Near his pits the overlying black clay was found to be 11 feet. At the pits, commencing at the surface—

3 feet dark micaceous clay, containing shells.
4 " clay, with shells and numerous marl grains.
6 " marl, grey, and containing shells and fine carbonate of lime.

15½ " marl, like the last, though varying slightly in color, some parts being darker and others lighter.

The last distance was bored, and ended in sand, for which if we add 8 feet, we have a total of 42½ feet.

A great number of other cuttings in the marl have been examined and measured, but in almost all cases the upper part of the marl is wanting, having been denuded or worn away, at some period since its deposition. In those cases where the upper part of the bed is plainly seen, it has not been penetrated to a sufficient depth to find out its thickness. At Cream Ridge, in Monmouth County, the marl is dug from seven to twelve feet deep. At Sculltown, in Salem County, the marl is dug from eight to fourteen feet; and near Marshallville, in the same county, it is dug from twelve to sixteen feet, and then stopped by water. At Batten's mill, near Swedesboro', in Gloucester County, the diggings are from eight to twelve feet.

The thickness of the ferruginous sand bed which overlies the first marl bed, as determined by levelling and making due allowance, for the descent of the marl, is from one hundred to one hundred and ten feet.

The second marl bed is not exposed in its full thickness at any one place, and it can only be determined by measuring the separate layers and taking their sum. The layer of green marl is opened—

10 feet at Shepherd's, near Blue Ball, Monmouth County.
20 " at Imlay's, on Crosswicks creek, below New Egypt, Ocean County.
13 " at Gaskill's, on the Rancocus, below Pemberton, Burlington County.
16 " Heritage's, near Union Cross Roads, Camden County.
14 " at Ware's, near Barnsboro, in Gloucester County.
14 " at Dickson's, near Woodstown, in Salem County.
18 " at D. Petit's, in Mannington, Salem County.

Which gives an average of fifteen feet—a number undoubtedly too small.

The layer of marl and shells is nearly

10 feet thick at Mr. Horner's, near New Egypt.

5 " at Bill's, near Blue Ball.

6 " at Heritage's, near Union Cross Roads.

4 " at Stratton's near Mullica Hill.

3 " at D. Petit's, Mannington.

Which gives an average of five and three-eighths feet. The layer is variable.

The layer of broken shells, corals, &c., which is opened in a great many places, does not anywhere show its full thickness. It has been penetrated without finding bottom,

14 feet at Mr. Pitcher's, near Long Branch;

20 " or more at Mr. D. Petit's, Mannington, which gives an average of seventeen feet.

The sum of these would give thirty-seven and three-eighths feet for the thickness of the bed—but it will probably be found too small.

From the levelling in Monmouth County, I estimate the *sand* between the second and third marl beds at about forty feet.

The *third bed* must be measured in the layers, like the second, and it will be convenient to take those in Monmouth County repeatedly, as it is only there that the three layers are found.

The green marl layer is

16 feet at Mr. Gardner's, in Deal.

18 " at J. Shafto's, Shark river.

18 " at Capt. Weeks', Squankum.

Average seventeen and one-third feet.

The ash colored layer is

10 feet at Van Benthuysen's Poplar.

10 " at G. Shafto's, Shark River.

10 " at Forman's, Lower Squankum.

Average 10 feet.

The blue marl layer is

14 feet at Abner Allen's, Deal.

8 " at Amos White's, Poplar.

9 " at Petit's, Shark River.

7 " at Forman's, Lower Squankum.

Average 9½ feet.

The sum of these is thirty-seven and five-sixths feet.

The green marl of the third bed is—

5—10 feet at New Egypt in Ocean County, and at Poke Hill in Burlington County.

12—12 " Pemberton.

12—14 " Vincentown.

6—8 " Christopher's Mill, near Marlton.

6—7 " Clementon.

Average 8 1-5—10 1-5 feet.

The strike, dip, and thickness, of these marl beds being known, may now be used in describing their geographical position. A reference to the map of New Jersey will be useful in studying out the following description. All the pits opened in the first bed lie to the northwest of the straight line mentioned on page 59, as being drawn from Red Bank to near Salem—their distance from it depending on their height above tide. In the examinations thus far made, the distance is about one mile for every thirty feet above that level. All the pits in the second bed, with a few exceptions, lie to the southeast of the above-mentioned line; and they are all to the northwest of the line mentioned on page 59, as being drawn from Long Branch to Swede's Bridge. The exceptions spoken of are those marl pits which have been opened high up in the Highlands, and in Sugar Loaf Hill in Monmouth County, in Mount Holly, Burlington County, and at a few other very elevated points. In the third bed, the openings in the central part of the State are on high ground, and are a little to the northwest of the last mentioned line; in Monmouth they are to the southeast of it.

The openings in the marl are principally made in valleys, and in the banks of streams, on account of the streams having washed

away the surface material of sand, clay, loam, and gravel, and left the marls more exposed than they are on the ridges. The accompanying sketch will convey an idea of the localities in which marl is very commonly dug. The drawing was made from the pits of the Hon. N. Stratton, near Mullica Hill, Gloucester County. A branch of Raccoon creek runs down the valley, and the sketch was taken looking towards the northwest, and down the stream. Piles of marl dug out and ready for removal, are seen near the banks, on both sides of the valley. Most of the marl is found below the level of the flat ground, but the pits from which it is dug are not seen, being filled up with top-dirt which is removed in uncovering other pits. The pile of stones seen in front is of the upper, calcareous, or yellow limestone layer of the second bed, and is found overlying the marl at this part of the valley. The lines of stratification seen in the bank, appear to be due to some action of air and moisture on the surface material, and have no relation to the marl. In the valley farthest down, the green marl is found immediately under the surface earth; nearer, a considerable layer of shells and greensand is passed through before coming to the pure greensand; and opposite to the point from which the view was taken, there is a thick layer of limestone and limesand above the layer of shells and greensand. The relative position of the several layers of the second marl bed are thus well shown, also the descent of the marl towards the southeast. As the marl is worked farther back from the stream, the banks become higher, but the marl continues on the same level, which lends support to the opinion that the bed is continuous under the high grounds, between the valleys. But it is also very common to strike the marl at a considerable depth in wells and other excavations, at a distance from the streams.

In describing the first bed of marl, in last year's report, two layers of black marl were mentioned, as of common occurrence. Further examination has shown that these layers are not uni-

MARL PITS, NEAR MULLICA HILL, GLOUCESTER CO

form, and that they are owing to a chemical change which is now going on. These black layers contain no shells, scarcely any lime, and they are in many cases acid in their properties, from the presence of sulphate of iron, (copperas,) or sulphate of alumina, (a kind of alum.) In a marl pit near Heading's Corners, Middletown, Monmouth County, the black marl is in perpendicular streaks—made evidently by the copperas from the surface soaking down through the bed. In these streaks no shells are seen, and there is no vegetation on the surface; while in the gray marl between, and adjoining them, the shells are of their natural appearance and composition, and white clover grows luxuriantly. A similar case was observed in Upper Freehold, Monmouth County, near Imlaystown. Sulphuret of iron (iron pyrites, or, as workmen call it, sulphur,) is common in the subsoil in many parts of the marl district, and the action of the air and moisture on this, with the clay of the soil, produces copperas and alum. Some of the black marls, when thrown out in heaps, become covered with a white efflorescence, showing that they contain sulphate of lime (plaster); others of them become covered with a yellowish white efflorescence, remain damp, even in dry weather, and have an inky taste, showing that they contain copperas.

The marl of this bed appears to be more sandy as we go towards the southwest. Specimens from Salem and Gloucester show to the eye a greater per centage of sand than those from the eastern part of Monmouth. In a letter to me in relation to the marls on the property of the North American phalanx, Mr. Chas. Sears says that in two different cases it has been mentioned to him, by men who have worked in the wet and muddy marl, that distinct streaks of phosphoric light have been observed on applying friction to their clothing or persons—and one of them says that he perceived the well known odor of friction matches. Each of the men related the circumstances without any knowledge of what the other had done.

In the bed of ferruginous sand, there is much more firmness in

its substance in the southwestern part of the State, and the traces of fossils are much more distinct in it. A very interesting collection of fossils from it has been made by Wm. Snowden, of Mullica Hill. For a number of miles, across Camden and Gloucester counties, the top of this bed is a layer of material almost like stone; it is from six inches to two feet in thickness, and consists of a mass of casts of shells cemented by oxide of iron. The most common fossil in this layer is the *Exogyra costata;* Belemnites are common and numerous; other forms are seen. Some of the fossils, particularly the Belemnites, are composed of phosphate of iron.

In many parts of this highly colored ferruginous bed, masses of light colored sand are seen, sometimes without any distinct separation from the surrounding material, and in other instances inclosed by a firm crust of oxide of iron—as if the agent which had colored the rest of the bed had failed to penetrate these masses. Streaks of the same light colored material are also seen in some places; Mr. Snowden showed me, in the bottom of Raccoon creek near Mullica Hill, one of this kind. It had the appearance of a light colored, sandy limestone; effervesced very slightly with acids; and the Belemnites in it were still unchanged, being composed of carbonate of lime.

The upper part of this bed contains some clay, and is the basis of an excellent soil.

In digging marl in the lower layer of the third bed, the bottom has usually been found to be a whitish earth—called *white marl* in Squankum and Shark river, and fullers' earth in New Egypt and all places farther southwest, where this marl is dug.

3. *Examination of other geological formations.*

A beginning has been made in the examination of the beds of clay which constitute a regular formation, extending across the State, and lying between the red sandstone and the greensand marl. In their development on the surface they occupy a belt of from ten to fourteen miles wide across the State, and in their ex-

tension down the Delaware to their termination in the upper part of Salem County, they are of variable width. Their strike is not accurately determined, but is between S. 45 deg. W. and S. 55 deg. W., a little more southerly than the marl. Their dip is to the southeast, and from the few observations it has been possible to make, it is thought the inclination is nearly the same as that of the marl.

Over much of this formation there is a thick bed of sand, gravel, and other drift material, which effectually hinders access to it. Their examination will be mostly confined to their outcrop on the Delaware and Raritan rivers—and during this season it has been confined to the latter of the two localities.

In this clay formation the lower part is made up of white and light colored clays, with intermediate beds of pure white sand, called fire-sand; over these lie the beds of darker colored clay, and the beds of clay containing streaks of greensand.

At Woodbridge, in Middlesex County, and near the red sandstone formation, great quantities of fire-clay are dug. At this place the surface material is usually red earth and stone, apparently drift from the red sandstone; under this is found, in some places, white and fine fire-sand, and in others black or dark colored clay. Under these is found the fire-clay—very uneven on its upper surface, as if it had been washed away in streaks or spots, after its deposition and before the sand and clay covered it.

In the bank of Thompson & Drake there is—

8—12	feet	black clay next the surface.
5	"	sandy fire-clay.
1—2	"	fire-sand.
6—12	"	best fire-clay.
5	"	sandy fire-clay.
8	"	white sand.

In the bank of Samuel Dally, after the earth is removed, there is—

2	feet	sandy fire-clay.

1 1-2 " fire-sand.
10—12 " best fire-clay.
6 " fire sand.

In the bank of Peter Melick there is, after the top earth is removed—

6—13 feet of best fire-clay.
2—4 " fire-clay containing red stains.
2 " sandy fire-clay.
Sand.

In Hampton Cutter's bank, which is some distance south-east of the others, and on lower ground, there is—

3—4 feet of loamy earth next the surface.
7—8 " of fire-clay.
7—8 " of sandy fire-clay.

There are several other banks opened in Woodbridge, but these are sufficient to give the arrangements of the layers of clay.

To the south of Woodbridge, and on much higher ground than the clay bed, there is found on Isaac Flood's land a bed of, apparently, decomposed granite; coarse angular grains of quartz, with decomposed felspar mixed through it, and numerous very small scales of mica. Still further south, and on lower ground, this bed is opened on lands of Mr. Demarest, Mr. J. D. Forbes, and Mr. Inslee. In these, the material is mostly finer than at Mr. Flood's, though some resembles his closely. It is of a bluish white color, sandy in consistency when drained, but pasty when worked up in water. It is a very fine micaceous sand, with some fire-clay intermixed, and streaks of clay passing through it. It is called kaolin by the people of the vicinity. Still further south, and on lower ground, this bed is worked by Mr. Hall and Mr. Watson, near Perth Amboy.

It is 2—3 feet thick at Mr. Flood's.
6—8 " (probably) at Mr. Demarest's.
10—12 " at Mr. Hall's.

The bed is underlaid by a dark colored but refractory clay.

These facts, it is believed, are sufficient to prove that the beds dip to the south, or southeast.

If we examine them in a direction from the northeast towards the southwest, they will be found to run nearly level. Following up this direction from Woodbridge, we see the clay in the old Woodbridge road, below Bonhamtown, and again on the side hill near the road to Compton's fire-sand banks; and on the southwest bank of the Raritan it is found on the land of Mr. Hobart, just below the mouth of Lawrence's brook. The sand which is found under the Woodbridge clay is coarse, angular, and crystalline; sand of the same quality is found on the lower upland, near the Raritan, below Bonhamtown, and it is also found near Milltown, three or four miles west of the Raritan.

The kaolin bed is cut in the streets of Perth Amboy, it is dug three-quarters of a mile back of Ellis' point, on Staten Island, where it is twenty-five feet thick, and on the southwest of the Raritan, it is dug by Mr. Flood on the Kearney property, by Coleman, Whitehead, and others at Burt's creek, by Mr. Bolton above French's landing, and by Mr. Whitehead on the hill at Washington. In the last two it is seven feet thick, and underlayed by black clay. On Staten Island, and also southwest of the Raritan, the kaolin is overlaid by fire-clay. The fire-clay is

20 feet thick in Kricher's bank, Staten Island.

10—17 feet on the Kearney property, near South Amboy.

12 feet at Coleman's, Burt's creek.

12—14 feet at Gordon & Co.'s, Burt's creek.

4—7 feet at Bolton's, near French's landing.

2—3 feet at Whitehead's, Washington.

A fire-clay is dug by Mr. Pharsan, on the hill west of South Amboy. It is dark colored, and does not appear to be connected with either of the preceding beds. Light colored and refractory clays are dug at several places in the interior of the State, and good fire-clay is found in the neighborhood of Bordentown.

A bed of potter's clay, which is much used in the making of stone ware, is opened on the shore at South Amboy, a mile and a half southeast of the railroad depot; and also at the head of Cheesequake's creek, three miles and a half farther southwest.

On Raritan bay, John H. Clark removes

11—25 feet of sand next the surface.
5—7 " of black clay.
9—17 " of blue stone-ware clay.
1—3 " of an ash colored sand, coal and pyrites.
8—13 " of stone-ware clay.

Morgan's clay-bank, adjoining Clark's, was worked near the shore last season, and the clay was thinner than the above, but when worked farther in the bank, is similar to Clark's.

At the head of Cheesequake's, Morgan's bank is

15—16 feet of sand.
7 feet of black clay.
10 feet of potter's stone-ware clay.

At the pits of N. Forman, there is

8—10 feet of sand.
10—15 " of black clay.
14 " of stone-ware clay.

At the Amboy Clay Co.'s bank, they dig about 18 feet of stone-ware clay.

In all these banks the clay is very variable in thickness, being uneven, both at the top and bottom.

These are the principal distinct layers of the fire and potter's clays that have been examined.

The interval between the Woodbridge and the South Amboy fire clays, is filled by layers of light colored clay and sand; some of these layers almost white; others darker colored, and containing much fossil wood and sulphuret of iron. The layers of sand make but a small portion of the whole. The clays are well exposed in the bank of the Raritan, at French's landing, where, as well as at Washington, they are largely used in making common brick.

The interval between the South Amboy fire and potter's clays, is also filled up by layers of clay and sand; the clay, as far as can be judged by the few exposures made, is darker colored than those above mentioned.

The black clay, which has been spoken of as overlying the fire and potter's clay, is quite unconformable to them, though it appears to descend and pass beneath the surface a little farther southeast, as observed on the shore of Raritan bay. It is remarkable for the large amount of sulphuret of iron it contains, and also for its fossil wood. The latter is found in several places, in sufficient quantity to be used for fuel.

This clay is less black, in its layers adjoining the marl, and contains occasional streaks and irregular spots of green sand; —so much that it is used for that substance in many places. It also contains numerous casts of shells and marine remains.

Fossils are not common in the light colored clays; fossil wood is found in some of the layers, in large quantity, and some very distinct impressions of net-veined leaves were examined in the clay at French's landing. In the potter's clay at South Amboy, Mr. Clark says they have followed up a single tree for ninety-three feet, and from a diameter of five feet, with which they commenced, to fourteen inches. He says that the workmen have in one part of their bank, found a considerable number of small shells.

In the potter's-clay banks, on the bay shore, the clay is frequently stained from the bottom upwards, of a peach blossom color. Such clay, though it can be used for some purposes, is not as valuable as good stone-ware clay.

The same kind of stain is frequently found in the bottom of the fire-clay beds.

It should be remarked, that no difference has been made in recording the depth of the fire clay, as to whether it is fire, alum, or paper clay. These are accidental differences, though important to the consumers. The best fire clays are also the

best alum clays—though clay containing a little suphuret of iron can be used for making alum, and is unfit for fire-brick. The common fire clay is white, with a bluish tinge; in some places it has lost this color, and is white, with a very faint buff hue. The latter is used for making satin-faced paper hangings, and is called paper clay. It occurs very irregularly. The change of color is undoubtedly owing to iron, which is a protoxid in the blue, becoming a peroxid in the white or buff. After burning one cannot be distinguished from the other.

In the formations above the marl, and lying to the southeast of it, some examinations have been made, and a number of localities have been visited, where shell marl and shell beds are excavated for manure. Among these shells, there are found in every bed some which are like those now living, and there are beds in which the shells are identical with those now growing in Delaware bay and the Atlantic Ocean, adjacent. In a geological classification, these beds must be considered as tertiary or recent formations.

The most extensive of the shell marl beds is that which is largely worked, at several places on the head waters of Stoe creek, and its branches in Salem and Cumberland counties. The most south-westerly of the workings in this bed, is that of Isaac W. Elwell, near Jericho, in Cumberland, and the most north-easterly are those on the Ellis Ayres estate, in Salem County, but near Shiloh, in Cumberland.

Mr. Elwell's marl is in a layer from eight to twelve feet thick, and covered by a bed of sand twenty feet thick. The marl is somewhat uneven on the bottom, and is much furrowed on the top. It is filled with shells, most of which are in a soft and decaying state. The color of the marl is yellow on the top, and blue towards the bottom; but the two colors are separated by a very irregular line, in some places higher, and in others lower. In the marl to the northeast, in the Cook neighborhood, and on the Davis property, the sand and marl are nearly the same as at El-

well's. At the pits of John J. Hummel, they first remove twenty feet or more of top sand, to uncover the marl. The surface of the latter is very uneven, rising in knobs, and then falling in depressions. The top of the marl is covered for a few inches by a layer of bright red earth; then, and more uniform, a layer of yellow earth, like ochre; then a layer of from six inches to two feet of dark lead-colored clay, containing no white shells, but numerous impressions; this layer is, in some parts of the pit, solid stone; underneath this is the marl, which is of a greenish lead-color, and from ten to fourteen feet thick, filled with shells, mostly in a crumbled state. This terminates in a layer of astringent clay, denominated soap-stone. The pits on the west branch of Stoe creek, and near the straight road to Salem, have a considerable layer of the hard stone, and the marl is astringent in some spots. The pits of Mrs. Ayres are not covered with so much sand, and the marl is of a more uniform blue, and harder than those in the pits farther down. The marl is full of soft shells, and like the rest, slakes to a finer powder when exposed to the air.

The fossils in these marls, both shells and bones, are very abundant, and promise an interesting study to the palæontologist.

There is another series of shell marl openings in Salem and Gloucester counties, which may be an extension of this bed, or possibly, from its geographical position, lower. It is exposed in the pits of Wm. Clawson, in Salem County, a mile and a half south of Woodstown, and a little east of the Allowaystown road. It is also seen on the farm of M. C. Jennings, in Gloucester County, about two miles south of Mullica Hill, and a little east of the Commissioners' road; and again in several places within two or three miles northeast of Mr. Jennings. It is variable in appearance, in some cases being light and sandy, and filled with fragments of white shells; in others much more clayey, without shells, and with a perceptible amount of sulphate of

iron. In mineral composition and appearance, the latter description applies to a clay formation, which is found through the valley of Alloways creek, on up to near Woodstown, and is again seen at other places along quite into Ocean County. I have a specimen taken from a well in this formation, in Upper Alloways creek, which contains impressions of shells.

In many places in the flat upland, not far from the creeks, or from the bay, or ocean shore, in digging wells or pits, beds of shells, identical with those now found in the neighboring waters, have been struck. Mr. Stewart, in Lower Alloways creek township, Salem County, near the shore, and just below the mouth of Alloways creek, says that in two or three wells which he has dug, he has found oyster shells at the depth of about twelve feet. In several wells near Fairton, Cumberland County, the same fact has been observed. On the east bank of Maurice river, a short distance above Port Elizabeth, on land of Jonathan Lore, there is a bluff bank of fifteen or twenty feet high. In this bank, at about seven feet above high water, there is a bed of oyster shells; the bed is solid, two or three feet thick, in blue mud, and the shells packed closely, just as in beds now under water. The mud covers them for two or three feet, and then there is sand to the top. Shell marl is also dug on the Manamusking, three-quarters of a mile from Port Elizabeth; the shells are imbedded in blue mud, and covered with two or three feet of sand. Farther down the river, at Leesburg, the same layer of blue mud and shells is found, from three to six feet under the surface sand. At Heislerville, still farther down Maurice river, the same species of shells are found, and occurring in the same manner. Again, in Cape May County, three or four miles south of Beesley's point, and a little west of the sea side road, on lands of Jonathan Godfrey, a similar deposit of blue mud and shells, covered by sand, is found. At Tuckahoe, in the same county, casts and impressions of the common clam are found in the gravel, a little south of the town. There

is no lime in these, but the forms are in gravel, cemented by oxide of iron. At the south part of the county, on land occupied by Downes Edmonds, Jr., it is common to find oyster and clam shells in the upland, one or two feet beneath the surface.

Of the deposits of sand, gravel, and clay, which cover so large a portion of the southern counties of the State, there are not yet facts enough collected to make any general deductions from. No distinct stratification of these materials has been found as yet. In the wells bored at Cape Island, to the depth of about one hundred feet, the materials passed through were similar to those on the surface. The gravel stones found on the beach, and in the banks, are of a singularly mixed character. The Cape May diamond is much sought after by strangers; it is probably a water-worn quartz crystal, and beautiful specimens are sometimes found. There are pebbles of quartz of every hue; agates are not uncommon; pebbles of limestone, and rolled limestone fossils are frequent.

At Dennisville, in Cape May County, the gravel is very coarse, many of the pebbles being from one to two inches in diameter. Boulders are first found here in coming up from the Cape. They are principally of a light colored sandstone, some very firm, and others friable. The marks of stratification are plain in them, and they are quite angular. Mr. Nixon, of Dennisville, showed me a boulder weighing forty or fifty pounds, flat, and oblong in form; one side of which was covered with very large quartz crystals. They were milky and much broken. Near Greenwich, in Cumberland, there is a spot of ground filled with stone like that mentioned as being found over the marl in Hummel's pits, near Shiloh. The most common boulders in Salem county are of a very cellular quartzose rock. They are usually not large, and very numerous in spots, but generally they are thinly scattered. In many places the sand and gravel is cemented with oxide of iron, and is firm enough to be quarried and used for building purposes. The fragments are commonly flat, and are called quoit-stones.

A fossil tooth was found in the gravel at Goshen, and was presented to the State collection by Mr. Jona. Ingham; and some beautiful specimens of petrified wood from the gravel near Bridgeton, were presented by Dr. Potter.

The skull of a mastodon was dug up in the meadow of John Ewens, near Pemberton, Burlington County, last spring. It was in a good state of preservation. Its length was two feet ten inches; and its breadth, in the widest part, was one foot ten inches. Other bones of the mastodon were found near the same locality several years since.

During the past season, while in the southern part of the State, my attention was frequently called to the rapid wearing away of the shores, and to the advance of the tide-waters on the land. Local causes were generally assigned for the increased height of the tides; but this and other phenomena were extended over so long a line of shore, that it was thought there must be some general cause for them; and this cause appears to be, the slow but continued settling or subsidence of the land.

At the mouth of Dennis creek, in Cape May County, and for several miles along the bay-shore, on each side of it, according to the local surveyors, the marsh wears away, on an average, about one rod in two years; and, from the early maps, it would appear to have been going on at that rate ever since the first settlement of the country. A map of Cape May, in the possession of Dr. Maurice Beesley, of Dennisville, and bearing the date of 1694, lays down Egg Island, the western point of Maurice River Cove, as containing 300 acres; at low water it now contains a half or three fourths of an acre, and at high-water it is entirely covered. All along the Delaware Bay and river where the marshes are banked in to keep off the tide, the banks or dykes are placed several rods from the water's edge, to allow for the wearing away of the marsh.

At Town Bank, which is the principal bold shore on the west side of Cape May, and where the first settlement was made as

early as 1691, the solid gravel bank, which is from twelve to eighteen feet high, wears away, according to the owner, Mr. Thos. Hughes, about one foot a year. The foundations of the houses first built were long since undermined, and the waters of the bay now occupy the spot where they originally stood. At Cape Island, on the Atlantic shore, the wear is equally rapid, a full mile having been worn in since the revolution, as I am informed by Mr. Ezekiel Stevens. During the war of that period a militia artillery company had its practicing ground here. Their gun was placed near a house which stood just outside the present shore line, and their target was set up three quarters of a mile east. This last point was at the outer edge of the cultivated ground, and there was a quarter of a mile of sand hills or *beaches* between that and the water's edge. The whole of this is now gone, and one of the boarding houses has been moved back twice, on account of the wearing away of the bank. The sand beaches on the Atlantic shore are drifting in every year. Dr. Leaming says that Ludlam's Beach, opposite his residence, has moved inward fully one hundred yards during the last twenty years; and that the salt marsh sods which formed west of the beach are now seen on the strand east of it.

That the tides rise higher upon the uplands than formerly, is the opinion of the oldest observers, upon the Atlantic and Bay shores, from Great Egg Harbor quite around to Salem creek. Their opinion is founded on the fact, that on the low uplands, or those going down to the salt marsh with a very gentle slope, the salt grass now grows where upland grass formerly grew; and where the land was in wood, narrow fringes of it next the marsh are frequently killed by the salt water, and marsh takes its place. Hon. Joshua Brick, of Port Elizabeth, estimates the amount of timbered land between Maurice river and West creek, in Cumberland County, which has been killed within the last fifty years, at one thousand acres. And the amount is proportionally great on all the low and wooded shores. Numerous

islands (spots of hard ground surrounded by salt marsh) which, within the memory of men now living, have been cultivated, and others which were in wood, have been entirely lost in the advancing marsh, and their location is only to be known by the shallowness of the mud which covers them.

In all the salt marshes on the sea shore of southern New Jersey, and also in the salt and fresh tide marshes on Delaware Bay and river, stumps of trees, of the common species of the country, are found with their roots still fast in the solid ground at the bottom of the marsh, and this at depths far below low water mark. A reference to localities for these is not necessary. The fact is known to every one living in the neighborhood of these marshes, and the evidence of it can be seen in the bottoms or in the banks of almost every ditch that is cut in them.

The time during which this settling has been going on cannot be estimated with any degree of accuracy. But some idea of it may be obtained by noticing the phenomena of the cedar swamps where buried timber is dug or *mined*. In these swamps, and in the salt marshes near them, underneath the standing trees, or under the stumps in the marsh, cedar logs are found buried—and these one under the other, in such numbers, and so sound, that they are valuable for timber. By sounding with an iron rod, these logs can be felt under the surface at all depths, from one to ten feet, and some have said for even more than that. At Dennisville a well was dug in the marsh eleven feet in depth. The mud near the surface was the common blue-mud of the marshes; at a small depth the peaty cedar swamp earth was reached, and in it cedar timber, logs, and stumps, were found for several feet, and near the bottom the sweet gum (*Liquidambar styraciflua*,) and the spoon-wood or magnolia (*Magnolia glauca*,) were found. The well reached hard bottom. The white cedar grows on peat, and its roots run near the surface, so that it might be supposed the mud had settled with them, were it not for the fact that, when cedar grows where the mud is shal-

low, so that its roots reach hard bottom, its wood is unfit for timber, the grain or fibres being so interlocked that it will not split freely. Such is found to be the case in the buried timber; the bottom layer, as it is called, is worthless. From this the inference is conclusive that the hard ground was above tide level when those trees grew. Large stumps are frequently found standing directly on other large logs, and with their roots growing all around them, and then other logs still under these, so that one soon becomes perplexed in trying to count back to the time when the lower ones were growing. Dr. Beesley, of Dennisville, some years since communicated to the newspapers an article on the age of the cedar swamps, which was copied by Mr. Lyell in his Travels in the United States, Second Visit, vol. 1, p. 34; in which Dr. B. says that he "counted 1080 rings of annual growth between the centre and outside of a large stump six feet in diameter, and under it lay a prostrate tree, which had fallen and been buried before the tree to which the stump belonged first sprouted. This lower trunk was five hundred years old, so that upward of fifteen centuries were thus determined, beyond the shadow of a doubt, as the age of one small portion of a bog, the depth of which is as yet unknown."

Mr. Thomas Shourds, of Hancock's Bridge, Salem County, informed me that the sluices in a meadow bank near his residence, on Alloways Creek, were fully three feet below low water mark—so low, indeed, that within thirty years he has seen them but twice. The bank was built about the year 1700. Sluices are usually made in marsh earth, but it is said they do not settle much. And, in this instance, there is good reason to believe they are properly placed for what the tide must have been when they were set. On the opposite bank of the creek from these sluices there is an oak stump standing, the roots of which are in the solid bottom, and the top of it is about the level of high tide. The top is square, as if cut off by an axe, and the longest time since it was cut can be little more than one hundred

and fifty years. And when alive it must have been not less than three feet higher than now, to be out of the way of the tide. Judge Brick, of Port Elizabeth, says the tides have advanced a foot within fifty years—which, it will be perceived, agrees with the evidence to be obtained from the stump. Many persons have been disposed to estimate the rate of subsidence higher than this —but, in general, the statements are rather from impressions than from any fixed marks to refer to. I am confident, however, that two feet in a hundred years, is not above the rate at which the shore is now sinking.

The change of comparative level of land and water, though not generally noticed, is by no means uncommon. Very full accounts of such changes have been collected, and published by Mr. Lyell, in his work on the Principles of Geology. He says that "recent observations have disclosed to us the wonderful fact, that not only the west coast of South America, but also other large areas, some of them seven thousand miles in circumference, such as Scandinavia, and certain archipelagoes in the Pacific, are slowly and insensibly rising; while other regions, such as Greenland, and parts of the Pacific and Indian oceans, in which atolls or circular coral islands abound, are as gradually sinking."

From some facts collected, it would appear that the change on our own shore, is not confined to southern New Jersey. In the salt marshes on the Raritan, between New Brunswick and Perth Amboy, buried wood and stumps are common. Some years since a canal was dug across the marsh, from Washington to French's landing, to cut off some of the bends in South river, and the Raritan. The marsh cut through was from one to four feet deep, with a sandy bottom. Hundreds of stumps of the common yellow pine of the country, were found with their roots still firm in the sand as they grew; and though most of them were removed, a few are still to be seen at low water. The general impression at Washington is that the tides are fuller now than formerly. The marshes at the mouths of the Passaic

and Hackensack are well known to contain great quantities of buried timber, and it is but a few years since they were covered with cedar trees. The same is true of the marshes on the shore of Long Island. Prof. Hitchcock, in his report on the Geology of Massachusetts, give accounts of buried wood, erect stumps and peat, being found in the sea, at or below low water mark, as at the harbor of Nantucket, at Holmes Hole, on Martha's Vineyard, and also near the southwest extremity of the same island. They are seen too on the north side of Cape Cod, also opposite Yarmouth, and in Provincetown bay. Mr. Lyell, in his second visit to the United States, mentions a submerged forest "at Hampton, on the way from Boston to Portsmouth," also one near Portsmouth, N. H., "now submerged at low water, containing the roots and upright stools of the white cedar, showing that an ancient forest must once have extended farther seaward." In his First Visit to North America, vol. 2, p. 143, he mentions a submerged forest somewhat similar near Fort Cumberland, in Nova Scotia. In the same work, vol. 1, p. 131, in speaking of the coast of Georgia, he says, "I even suspect that this coast is now sinking down at a slow and insensible rate, for the sea is encroaching and gaining at many points on the fresh water marshes. Thus at Beauly, I found upright stumps of trees of the pine, cedar and ilex, covered with live oysters and barnacles, and exposed at low tides; the deposit in which they were buried having been recently washed away from around them by the waves." He records other observations in relation to the submerged trees at the mouth of Cooper river, near Charleston, and of the Altamaha, in Georgia. He quotes Bartram, the botanist, who wrote in 1792, as saying, "It seems evident even to demonstration, that those salt marshes adjoining the coast of the main, and the reedy and grassy islands in the rivers, which are now overflowed at every tide, were formerly high swamps of firm land, affording forests of cypress, tupelo, magnolia grandiflora, oak, ash, sweet bay, and other timber trees, the same as

are now growing on the river swamps, whose surface is two feet or more above the spring tides that flow at this day. And it is plainly to be seen by every planter along the coast of Carolina, Georgia and Florida, to the Mississippi, when they bank in these grassy tide marshes for cultivation, that they cannot sink their drains above three or four feet below the surface, before they come to strata of cypress stumps, and other trees, close together as they now grow in the swamps."

From the deposits of shells of recent species which were mentioned on page 76 as being found above the present high tide mark, it may be inferred that, at a period not very remote, our New Jersey shores were considerably lower than at present. This inference is corroborated by the appearance of the ridges of drift sand near Cape May. They are well shown on the right of the road from the steamboat landing to Cape Island. At about a quarter of a mile from the landing the innermost sand-ridge or beach is seen. This ridge is parallel to the present bay-shore, and lies upon the gravel which is the fast-land of the Cape. Between this and the bay-shore there are several parallel ridges of drift sand, in which the sand extends down at least to the water-level. It appears as if, at some former time, the waters of the bay had washed the gravel bank which now underlies the innermost sand ridge; and afterwards, as the waters receded, the sand from the strand was blown up, and lodged on this bank; and as the waters receded still farther from the original bank, other and parallel ridges of sand had formed in succession. The ridges have been formed long since, and have reared a heavy growth of black oak timber. They have ceased to advance, and are now wearing away with the advance of the water upon the land.

The indications, then, are that at some comparatively recent period, the ground has been several feet lower than it is now; that it has since been elevated to a height several feet above that at which it now is; and that it is now, and has been for a long time past, sinking slowly.

This gradual elevation and subsequent depression may have given to our coast its peculiarities. For almost the whole length of New Jersey, the main land is separated from the ocean by a strip of salt marsh, in some places several miles wide. On the outer edge of this marsh, next the sea, is a row of long, narrow sand islands, or *beaches*.

In many places where the waves wash against the head bank, the material is continually being worn away, and deposited as a sand-bar, or shoal, at some distance from the shore, and parallel to it, leaving comparatively deep water next the land. If we suppose this to have occurred during the former depression of the land, a series of shoals would have formed parallel to the coast. When a rising of the land took place, these shoals would be raised above the surface of the water, and become the basis of our present *beaches*; shrubs and trees would soon grow on them, to protect their surface, and to catch the sand which would drift up from the strand. The lower ground back would finally be elevated above the water, and would be covered by vegetation, shrubs, and trees; until a subsequent depression of the surface should again carry them below the tide-level, when they would become salt marshes—filling up with mud as the advancing tides would bring it in, and thus keeping their surface at high-water mark.

Sufficient evidence has not yet been collected to demonstrate this theory, but there is enough to render it highly probable.

4. *Chemical examinations, and some practical suggestions on them.*

The following analyses of marl, from different parts of the State, are presented, as good samples of this most valuable fertilizer:

1. *Analysis of a marl from Squankum, Monmouth Co.*

Water - - - - - - -	10.600
Silica - - - - - - -	51.162

Protoxid of iron	16.200
Alumina	6.100
Potash and soda	4.274
Lime	3.478
Magnesia	2.037
Phosphoric acid	4.540
Sulphuric acid	0.429
	98.820

This specimen was from the pits of Hance Herbert, and was taken from near the middle of the layer. It is a beautiful green marl, free from shells, and containing but very little sand. The marl grains are very small. It is very slightly acid in its reaction.

The specimen was dried by exposure to the open air—and it, as well as the following ones, was as dry as it could be made without artificial heat. Traces of manganese and of chlorine are to be found in all the marls, and a little carbonic acid is almost always present.

2. *Analysis of a marl from near Pemberton, Burlington Co.*

Water	10.410
Silica	55.930
Protoxid of iron and alumina	22.855
Potash	5.800
Lime	1.640
Magnesia	1.013
Phosphoric acid	1.680
Sulphuric acid	0.957
	100.285

This marl is from the pits of Joshua Forsyth, about three miles northeast of Pemberton. It is a dark green marl, without any shells, and is not acid. The specimen was taken from a heap.

3. *Analysis of a marl from Clementon, Camden Co.*

Water	10.640
Silica	56.200
Protoxid of iron	14.930
Alumina	6.000
Potash	5.375
Lime	1.985
Magnesia	1.615
Phosphoric acid	2.640
Sulphuric acid	0.439
	99.824

This marl is from the pit of Geo. Adams, in Clementon. It is dark green in color, and almost pure marl grains. It is not acid. The specimen was taken from a heap.

4. *Analysis of a marl from near Freehold, Monmouth Co.*

Water	9.800
Silica	54.110
Protoxid of iron and alumina	21.700
Potash and soda	6.985
Lime	0.482
Magnesia	3.789
Phosphoric acid	1.036
Sulphuric acid	1.437
	99.339

This specimen was taken from the pit of J. Shepherd, about a mile southwest of Blue Ball. It was taken from near the middle of the pit. It is almost pure marl grains, and is of a rich olive green color. It is decidedly acid.

5. *Analysis of a marl from New Egypt, Ocean Co.*

Water	12.050
Silica	49.768

Protoxid of iron and alumina	22.927
Potash and soda	5.784
Lime	2.563
Magnesia	2.795
Phosphoric acid	1.582
Sulphuric acid	2.267
	99.736

This marl was taken from the pit of Samuel Horner, near New Egypt. The specimen was from near the top of the green marl. It contains a few reddish colored shells, but the greatest portion is made up of clean greensand marl. It is not acid.

6. *Analysis of a marl from Pemberton, Burlington County.*

Water	9,600
Silica	49.340
Protoxid of iron and alumina	25.341
Potash and soda	6.920
Lime	1.217
Magnesia	4.210
Phosphoric acid	2.395
Sulphuric acid	0.133
	99.156

This marl is from the pit of S. R. Gaskill, on the north branch of the Rancocus, below Pemberton. It is from near the middle of the pit, and is a fine colored, clean greensand. It is not acid.

7. *Analysis of a marl from Blackwoodtown, Camden County.*

Water	11.000
Silica	49.940
Protoxid of iron and alumina	22.968
Potash and soda	6.306
Lime	2.367

Magnesia - - - - -	2.714
Phosphoric acid - - - - -	3.660
Sulphuric acid - - - - -	0.625
	99.580

This specimen was taken from the pit of Mr. Marshall, at Blackwoodtown; about midway between the top and bottom of the green marl. It is free from shells, and is not acid. Small crystals of sulphate of lime (plaster) are scattered through it.

Analysis of a marl from Mullica Hill, Gloucester County.

Water - - - - - -	10.260
Silica - - - - - - -	46.660
Protoxid of iron and alumina - -	24.921
Potash and soda - - - -	6.818
Lime - - - - - - - -	2.865
Magnesia - - - - -	3.089
Phosphoric acid - - - - -	3.599
Sulphuric acid - - : - -	0.982
	99.194

This marl was taken from the pit of N. Stratton, about a mile east of Mullica Hill. It is a good specimen of the green-sand marl. It is not acid.

Analysis of a marl from Woodstown, Salem County.

Water - - - - - - -	8.840
Silica - - - - - - -	49.780
Protoxid of iron - - - -	19.800
Alumina - - - - - - -	8.040
Potash and soda - - - -	6.815
Lime - - - - - - - -	1.048
Magnesia - - - - -	1.812
Phosphoric acid - - - - -	2.651
Sulphuric acid - - - - -	0.112
	98.848

This specimen was from the pit of Richmond Dickson, near Woodstown, and was taken from a wagon. The marl grains are coarse, clean, and of a yellowish shade of green. It was probably taken from near the bottom of the green layer, and is scarcely an average of the marl in the bed.

Analysis of a marl from Marlboro, Monmouth County.

Water	12.200
Silica	38.700
Protoxid of iron and alumina	27.690
Potash and soda	4.467
Carbonate of lime	13.910
Magnesia	1.213
Phosphoric acid	1.140
Sulphuric acid	0.309
	99.629

This specimen was taken the pit of W. H. Conover, at Marlboro, and is a good sample of his best grey marl. It is made up of green grains, largely mixed with carbonate of lime, and a light colored clay. It is not acid—but efferverces rapidly when any strong acid is poured on it.

Analysis of a marl from Shelltown, Burlington County.

Water	5.700
Silica	67.260
Protoxid of iron	10.267
Alumina	4.360
Potash and soda	5.161
Lime	0.622
Magnesia	1.943
Phosphoric acid	0.178
Sulphuric acid	3.420
	98.911

This specimen was taken from a pit of Mr. Howard, near the bridge over Crosswick's creek, at Shelltown.

The marl is fine grained, dark green in color, and is irregularly mixed in the dark chocolate colored clay. It is acid in its properties, and when used with caution, is highly fertilizing in its action.

Of the marls whose analyses are given, those marked 1, 2, and 3, are from the third or highest bed; those marked 4, 5, 6, 7, 8, and 9, are from the second or middle bed; that marked 10 is from the first or lowest bed, and that marked 11 is from the clay which underlies the marl.

Analysis of a limestone from Salem County.

Water	0.500
Carbonate of lime	69.610
Magnesia	1.815
Peroxid of iron	2.810
Alumina	0.910
Silica	23.310
Phosphoric acid	0.039
Sulphuric acid	0.064
	99.058

This limestone was taken from the farm of Samuel Allen, in Mannington township, and is thought to be a fair sample of the limestone which is found in the calcareous layer of the second marl bed.

Analysis of a limesand, or marl, from Salem County.

Water	0.750
Carbonate of lime	84.730
Magnesia	1.404
Peroxid of iron	3.260
Alumina	0.860
Silica	8.110
Phosphoric acid	0.206
Sulphuric acid	0.230
	99.550

This specimen was taken from the pits of John Fowler, near Swede's bridge, in Mannington township, and is a sample of the loose variety of the upper part of the calcareous layer of the second marl bed.*

The value of these marls is best seen in the rich and highly cultivated district, which has been improved—almost made by their use; but it may be interesting to examine the causes of their great value in agriculture; and to compare them with other fertilizers. For example: the potash alone may be taken at an average as 5 per cent. of the whole weight of the marl; a bushel when dry, weighs eighty pounds, and in the proportion mentioned, would contain four pounds of potash,—this is nearly as much as there is in a bushel of unleached wood ashes. Or the phosphoric acid, the average of which is not less than two per cent. of the whole, and in many of the marls it is considerably above that, may be compared with superphosphate of lime. According to the analysis of several specimens of superphosphate, by S. W. Johnson, published in the Country Gentleman, vol. 1, p. 131, its average amount of phosphoric acid is 17 3-8 per cent., or from four to nine times as much as the marl, a difference by no means as great as between the prices of the two articles. Besides these constituents, the lime, the sulphuric acid, the oxide of iron, the soluble silica, and the magnesia, are all useful. It is probable that the great value of the marl is to be found in the fact, that it contains nearly all the substances necessary to make up the ash of our common cultivated plants. The following table, containing the amount and the composition

*The preceding analyses have been made under my direction, principally by Mr. Julius Kock, a competent chemist, a student of the Universities of Giessen and Marburg. The usual methods were adopted for the analysis of silicates soluble in acids. The alkalies were separated from the magnesia by acetate of baryta. The phosphoric acid was separated by molybdate of ammonia. There appears to be a small amount of organic matter in all the marls, but no attempt has yet been made to ascertain its composition.

of the ash, in different crops, grown on an acre of ground, is inserted for the purpose of comparison. It is from Boussingault's Rural Economy, p. 366 of the American edition:

TABLE.

CROP.	Dry crop.	Ashes, per cent.	Quantity of ashes per acre.	Phosphoric acid.	Sulphuric acid.	Chlorine.	Lime.	Magnesia.	Potash and soda.	Silica.	Oxide of iron, Alumina, &c.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Potatoes . . .	2828	4.0	118	13	8.0	3	2	6	58	6	17
Potato tops . .	5042	6.0	303	33	7.0	4	7	5	135	39	16
Wheat. . . .	1052	2.4	25	12	0.3	. .	0.8	4	7	0.4	. .
Wheat straw .	2558	7.0	179	5	1.5	1	15	9	17	121	1¾
Oats	975	4.0	39	6	0.4	0.2	12	3	5	21	0.6
Oat straw . .	1176	5.1	60	1½	2.5	3	5	15	17	24	1
Clover. . . .	3693	7.7	284	18	7.0	7	70	18	77	15	0.9

A comparison of the analysis of the marl with those of the ash, shows how abundantly it supplies the mineral substances needed for the growth of vegetation.

The peculiar adaptation of these marls to the growth of potatoes has long been known. Causes for this may be seen in the large amount of potash and of oxide of iron, which are found both in the marl and in the ash. That the latter substance has an important influence, may also be inferred from the well known fact, that the marls near the surface, and which have been most changed by the action of air and moisture, but still contain their oxide of iron, are as useful as any others for a single crop of potatoes.

The growth of white clover upon marl banks, or marl heaps, has come to be a test of their character; those containing lime soon become covered with a spontaneous and luxuriant growth of this clover; on the contrary, none of it is ever seen upon marls

which are acid in their properties, or which contain sulphate of iron. An explanation of this is at once perceived, in the composition of the clover ash.

Those who have used the rich green marls with beneficial effects for a few years, have observed that they do not answer as good a purpose as at first, and that liming fields which have been thus treated, makes an excellent change, increasing the crops, and restoring to the land the property of being benefitted by marl. The analysis shows that such marls contain but little lime; and their failure to act may be due to this cause. Those marls containing a large amount of lime never fail to produce good effects, though applied for years without any other manure. Lime appears to aid the marl, not only by furnishing this constituent when it is needed, but also by rendering the marl more soluble, and thus more free to give up its fertilizing principles to the growing plants. This has been shown in instances where the marl, when applied alone on land, produced no effect; but on liming it well has produced as good crops as marls of the highest repute. And that this effect was due to the marl, was known by the same dressing of lime being applied upon other and adjoining fields, which had not been marled, and no perceptible effect was observed. It produces the same effect, too, upon many soils which, though fairly green with the marl grains in them, were yet almost barren; it has brought them at once to a high state of fertility. There are marl pits opened in all the beds, which are reputed to be worthless, and which do seem to be quite inert; though analysis shows them to contain the same constituents with other marls which are active in their properties. The size of the marl grains, undoubtedly, has some influence on the quickness of their action, the finest being best. But besides this, some of them are more readily soluble than others. Those which are dug in valleys or in any locations where the surface water does not soak through them and run off below, where they have never been drained and dry, are always the easeist dissolved, being

readily decomposed by carbonic acid and water.* Many of the *dry bank* or *hill* marls appear to have undergone a kind of seasoning, such as stone goes through when taken from the quarry and exposed to the weather—they become harder and less easily acted on. The experience of the farmers with the active marls lends support to this view; in that they find the heavy dressings, applied at long intervals, as was formerly the practice, are not as beneficial as the same amount applied in lighter and more frequent coats. When first taken from the pit it is most active, and gradually becomes inert. Lime mixed with such marls, or applied on them in the soil, will render them more easy of decomposition, and thus favor their action.

The marl is used in great profusion in some localities, where it is easily obtained, but its beneficial effects are to be seen in cases where only small quantities are used—small enough to sow it over the ground like ashes. And it would undoubtedly be found to pay well, even if carried long distances by railroad, or by water. Since the opening of the Freehold and Jamesburg Railroad, large quantities of marl have been sent over that road to various places on the Camden and Amboy Railroad. The New Jersey Farmer gives the amount carried over the road during the past year at 360,000 bushels. Much of this is hauled from Squankum, (seven miles) by teams. It is worth seven cents a bushel at Freehold.

The opening of other railroads through to different parts of the marl district, would be useful in extending the benefits of this valuable fertilizer. There are now a number of places where it is readily accessible by water. On the shore of Sandy Hook bay, below the Nevesink lights, the marl could be run from

* Prof. Booth, in his Report on the Geology of Delaware, p. 150, says that, "by a well charged solution of carbonic acid a large portion of the green sand was decomposed in a few days, and a weak solution induced the same effects in a few weeks."

the banks directly into boats. And the same convenience of access is found for several miles along the north shore of the North or Nevesink river, and at several places farther south the marl is found, but a short distance from the sea shore. On the Delaware side of the State, several of the creeks are navigable quite up into the marl district, and vessels could be cheaply loaded in them.

Analysis of shell marls from Stoe Creek.

Water	2.400	7.00
Silica and sand	79.160	42.70
Peroxid of iron	3.562	10.30
Alumina	.442	
Potash	1.227	0.68
Lime	7.500	21.43
Magnesia	0.884	0.20
Phosphoric acid	0.420	0.98
Sulphuric acid	0.166	
Carbonic acid	4.030	16.03
	99.791	99.32

These marls were from the pits of Isaac W. Elwell, Stoe Creek township, Cumberland County. They are of the common bluish green color, and contain a large per centage of crumbled shells.

Experience has shown these marls to be possessed of valuable fertilizing properties. Their action is said to be not as quick as some of the greensand marls, but they produce a permanent improvement in the soil.

The various deposits of oyster and clam shells which have been mentioned, have not been analysed. The shells are evidently unchanged, or only slightly crumbled, and are mixed in with blue mud, such as now forms in the bays and marshes where tide-water flows, and more or less sand. Their value

must depend partly on the lime which they contain, and partly on the improvement in the texture of the soil, which their earthy matter would effect. They have not yet received, from farmers, the attention which they deserve.

The calcareous layer which is the top of the second bed of greensand, and which is known in different parts of the district as *yellow marl*, *gray marl*, *lime sand*, &c., consists of carbonate of lime, from crumbled and powdered shells, corals, &c., mixed with white sand and scattering grains of greensand. The carbonate of lime in it is from 50 per cent. upwards, in the whole mass, and is its valuable ingredient. Farmers are in the habit of comparing its effects with those of green marl, and judging its value in that way. They are quite unlike in their action, and wherever it is possible should be applied alternately to the soil, each tending to develop the useful properties of the other.

The blue-mud of the tide marshes along the ocean, bay, and creek shores of all the southern part of the State, is a valuable repository of fertilizing material. In othe rcountries where agriculture is much advanced, such deposits are highly prized for improving the texture of light soils, and for furnishing useful mineral constituents to it. Its extreme fineness renders it peculiarly valuable for the latter purpose. Its use is but just commenced in New Jersey, but wherever tried it has given satisfaction. From a number of instances of its use, the two following may suffice. Near Cape May Court House the salt-marsh mud has been used by R. C. Holmes, Esq. He composts it with one twentieth as much stone lime, and leaves it exposed to the weather for a year or two, to leach out the salt. On his sandy loam it produces fine crops of wheat, corn, and grass. Mr. Coombs, of Port Elizabeth, has used mud from the Maurice river marshes, to fine advantage. His soil is a very poor and light sand—so poor that, with ordinary cultivation, it does not yield more than ten bushels of corn to the acre. By the application of from sixty to eighty loads of mud to the acre, it is made a

permanently retentive soil, which, with good cultivation, yields fifty bushels of corn, or twenty bushels of wheat, to the acre.

The taking of fish, king-crabs, &c., to be used for manure, has been occasionally practiced by our farmers near the sea shore, and their use in a raw state, or in compost, is well understood in the immediate neighborhood where they are caught; but few attempts have been made to preserve them in a state for transportation to a distance. The remarkable effects which have attended the use of guano, and other highly concentrated manures, and the increasing demand for them, have turned the public attention to our own sources of supply, and the preparation of portable manures, from the products of our own country, is felt to be of great importance.

Immense quantities of moss-bunkers and other fishes, are caught upon our shores, but no attempts are known to have been made, in the State, to prepare manure from them; and no systematic effort has yet been made to collect statistics of the numbers which are or might be annually taken. Some particulars have been collected in regard to the king-crab, which are worthy of attention.

This creature, which is known under the names of Horse-foot, King-crab, and Sea-spider—the *Polyphemus occidentalis* of the naturalists—is common on all our Atlantic coast; but it seems to find a particularly congenial location in the lower part of Delaware Bay. It comes to the shore to deposit its eggs in the sand, in the early part of summer; the largest number, it is said, in the old of the moon in June, though they are abundant for several weeks before and after that time. They come in such numbers that the beach is literally covered with them for nearly forty miles up the bay-shore, from Town Bank in Cape May County. They weigh, on the average, about four pounds each; and, at a very moderate calculation, a million of them could be picked up on a mile of beach in one season. They are used in great numbers as feed for hogs, and their eggs are shovelled up in wagon-loads, and carried off to feed to chickens. Many of

the Cape May farmers have thrown them up in piles, and composted them with earth, as a manure for wheat, and the effects they produce are remarkable. The poorest soils that can be found, by a dressing of from 2,000 to 4,000 on an acre, will produce twenty or twenty-five bushels of wheat, and thirty bushels is not an uncommon crop. This testimony in regard to their fertilizing action is confirmed by the experience of a number of farmers of whom I have inquired, and yet there is a singular prejudice against them. It is said that corn or clover will not thrive on the soil where they have been used—but that they bring in sorrel. This latter fact has been mentioned by several, but I am inclined to think it a difficulty of but little moment, even if entirely correct. The crabs contain but little mineral matter, and there may be a deficiency of that in the soil, after a heavy crop of wheat has been raised; but a dressing of lime or ashes will effectually correct this deficiency. Mr. Thos. J. Bate, of Fishing Creek, has used them in this way, and has had good crops of corn and grass after them. Some others have succeeded in the same manner, by the use of lime.

Mr. Jonathan Ingham, of Salem, and Mr. Thomas Beesley, of Dennisville, have erected a factory at Goshen, for preparing a manure from these crabs. They dry and grind them, and then mix them with charcoal, plaster, and other deodorizing materials, and sell the preparation under the name of *Cancerine.* It is a black powder, of a fishy smell, and when wet and allowed to stand for a few days, gives off a strong odor of ammonia. Prof. Booth, of Philadelphia, has analyzed it with the following results:

Analysis of Cancerine.

Ammonia	25.57	per cent.
Organic matter	29.23	"
Phosphate of lime	5.90	"
Sulphate of lime	10.32	"
Silex	1.20	"
Water	26.10	"
	98.32	

The ammonia, which many agriculturists esteem as the valuable fertilizing ingredient in concentrated manures, is more than one quarter part of this; in guano it rarely amounts to more than one sixth. It contains less mineral matter than guano, but this is a deficiency which may be supplied at a much lower price—by lime, wood ashes, greensand marl, &c.

The cancerine is sold at a rate considerably lower than guano; and though its value has not yet been shown in the crops raised by it, yet I cannot but think it promises to be a most valuable addition to the fertilizers now in use; and that it is the beginning of a branch of manufacture, which must supply our farmers with guano when the deposits on the Peruvian islands are exhausted.

Analysis of a Woodbridge fire-clay.

Water	14.640
Silica	39.760
Protoxid of iron and manganese	0.940
Alumina	42.850
Potash	0.477
Lime	0.398
Magnesia	0.650
	99.715

This specimen of clay was taken from the bank of Mr. P. Melick, of Woodbridge, Middlesex County, and is a sample of the best fire or alum clay.

Analysis of a South Amboy fire-clay.

Water	14.480
Silica	39.710
Peroxid of iron and manganese	0.260
Alumina	44.000
Potash	0.545
Lime	0.342
Magnesia	0.326
	99.663

This specimen of clay was taken from the bank of Mr. Coleman, on Burt's creek, near South Amboy. It is a good specimen of the variety of fire-clay, which is used for facing paper hangings, and is sold as *paper clay*.

Fire bricks made from these clays, stand an intense heat better than the imported bricks, and being afforded at a lower price, they are gradually coming into use, in place of the foreign ones. The material for not less than 50,000,000 fire bricks is annually sent into market from Woodbridge, Perth Amboy, South Amboy, and its vicinity. Fire clay is worth from \$2 to \$2 50 a ton, and first and second quality fire bricks are worth \$35 and \$30 a thousand.

For the facing of paper hangings, these clays are unequalled in the fine surface they give; though they are not quite as white as some others. There are not less than two thousand tons sold annually for this purpose. The price is from \$8 to \$9 a ton, in barrels.

This clay supplies all the alum works in the country. About two thousand tons a year are consumed in this manufacture. Its price is the same as that of fire clay.

In the making of porcelain and fine earthen ware, but little is done in our country. The potteries at Jersey City, and at Green Point, are said to use these clays in making their ware; and they are used at Trenton in making porcelain door knobs, and other door trimmings. The clay answers every requirement in point of quality and color, and is afforded at less than a quarter the price for which it could be imported.

Analysis of a stoneware clay from South Amboy.

Water	6.080
Silica	71.800
Protoxid of iron	1-314
Alumina	19.050
Potash	0.613

Lime	0.314
Magnesia	0.794
	99.965

This is a specimen of the stoneware clay from the bank of J. H. Clark, of South Amboy, and is a fair sample of the clays of that vicinity.

This clay is valuable for the superior quality of stoneware made from it. It is sent to all parts of our country, and into Canada. About ten thousand tons a year are needed to supply the demand. Its price is $2 a ton.

5. *Progress of the survey in different counties.*

The progress of the work in the different counties, has been pretty nearly indicated in the preceding part of the report. The geological survey is not completed in any of the counties of the southern division.

In Monmouth County most of the labor is done. Specimens of marls, fossils, &c., have been collected from all parts of the county. The County Agricultural Society, through committees in every township, have, also, collected such specimens of marl as they judged important to have examined, and have forwarded them to me. The different formations have been accurately traced out, over about two-thirds of the county, and levels for constructing the proper explanatory sections have been carried over the same portion. The chemical examination of the marls is well advanced.

In Salem the survey is carried over nearly the whole county. With the assistance of William Snowden, who resided in the county for a considerable time, and is familiar with it, specimens have been collected from the principal marl diggings, also many soils and fossils; and most of the notes necessary to a full geological description of the county have been made.

Cape May is nearly completed; all parts of the county

A CEDAR SWAMP, CAPE MAY CO.

have been visited, and specimens of interest collected. A further examination of some of the marshes and swamps, and the survey will be finished.

In Cumberland and Middlesex counties, a considerable amount of work has been done.

A few points of interest have been noticed in the course of the survey, which not coming appropriately under any of the preceding heads, may be presented here.

The *Cedar Swamps* are a remarkable feature in the forests of southern New Jersey. They are common in all the counties south of Monmouth, but probably the most extensive are in Cape May, and the adjoining parts of Cumberland and Atlantic counties. The Cedar Swamp creek, which runs into Tuckahoe river, and Dennis creek, which runs into Delaware bay, head in the same swamp, and the whole length of the two streams, a distance of seventeen miles, is one continuous cedar swamp. The wood is the white cedar, the *Cupressus thyoides* of the botanist. The original growth of trees which covered these swamps at the first settlement, has all been cut off; scarely any are now to be found more than one hundred years old, and it is usual to cut them at fifty or sixty years. Formerly they attained a great age. Mr. Chas. Ludlam counted seven hundred rings of annual growth in an old tree, which was living when cut down, and Dr. Beesley counted 1080 in another. The trees stand very thick upon the ground and grow rapidly at first, but as they increase in size and crowd each other, the tops become thin, and the annual growth exceedingly small. The rings near the centre of a large cedar log are often almost an eighth of an inch in thickness, while those near the bark are not thicker than paper. Trees four or five feet in diameter have been found, but this is uncommon, and in the second growth timber they are much smaller.

The accompanying cut was made from the drawing of a swamp of ninety years growth. A swamp of sixty years growth will yield from 4000 to 7000 split rails, halves and quarters; be

sides the top poles, or *cullings*, and a considerable number of logs for sawing. And in the older swamps, the product is proportionally large. The value of an acre of such timber is from $400 to $1000, and some acres are thought to have yielded a larger sum still. The soil in which these trees grow is a black, peaty earth, composed of vegetable matter, which when dry will burn.* This earth is of various depths, from two or three feet up to twenty or more—and the trees which grow on it have their roots extending through it in every direction near the surface, but not penetrating to the solid ground. When this earth is open to the sun and rains, it decays rapidly, but when covered with a growth of trees, and so shaded that the sun does not penetrate to the ground, it increases rapidly from the annual fall of leaves, and from the twigs and small trees which die and fall. Mr. Charles Ludlam recently found a log sawed off at both ends, which was entirely buried in the swamp. It was about a foot in diameter, and he knows that it was cut fifty or sixty years since. This process of covering and preserving timber has been going on for a long time. Trees are found buried in this peaty earth at all depths, quite down to solid ground. The buried logs are quite sound, the bark on the under side of many of them is still fresh in appearance, the color of the wood is preserved, and its buoyancy retained. When these logs are raised and floated in water, it is observed that the side which was down in the swamp is uppermost. The buried trees are some of them found with their roots upturned, as if blown down by the wind, and others are broken off as if they had stood and decayed, till too weak to support their own weight. The accompanying view, taken in the swamp of Mr. Henry Ludlam, will give an idea of the manner in which the logs lie. It, of

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* The amount of ash left by its burning is astonishingly small. In two trials which I made, the amount of ash in the dried earth was only three and a half per cent. It was almost insoluble in acids, and had not the slightest alkaline taste. It was mostly silica.

FALLEN TIMBER IN CEDAR SWAMP CAPE MAY CO.

course, can show only a few of the uppermost ones; and these are unusually well exhibited, the swamp having been cut off fifty years ago, and its surface much decayed by exposure to the sun and rain during that time.

The most prominent object in this drawing is a large log, which is seen extending across from one side to the other; another log partly decayed lies across it, and underneath another appears, which has had a piece cut out for working into shingles; other logs are also seen, lying some over, others under those already mentioned. To the right of the large log is a stump, which has its roots running under the log, showing that it is as old, or older, than the fallen tree; to the left, and partly on the log, with one of its large roots growing across, another old and decayed stump is seen. From its position, we may safely infer that the latter has grown, died, and decayed, since the large tree fell.

These logs are so abundant in some parts of the swamp, and in the salt marshes bordering on them, that a large number of men are constantly occupied in raising and splitting them into shingles. In Mr. Ludlam's swamp, this business was commenced fifty years ago, and has been carried on every year since, and though the logs are not quite so plenty as at first, enough are still found to repay the workmen. The size of the logs is from one and a half to three feet, though four feet is not uncommon, and I have heard of them five or six, and in one instance seven feet in diameter. Occasionally a log is found that will work for thirty feet, but generally the length is less than this.

In searching for logs, the workman uses an iron rod, which he thrusts into the mud till it strikes one; then, by repeated trials, he judges of its direction, size, and length. The next trial is by digging down, and if posssible getting a chip from it. By the smell of this, the experienced shingler can tell whether the tree is a *windfall* or a *breakdown*, or in other words whether it was blown up by the roots, or broken off. If judged to be worth

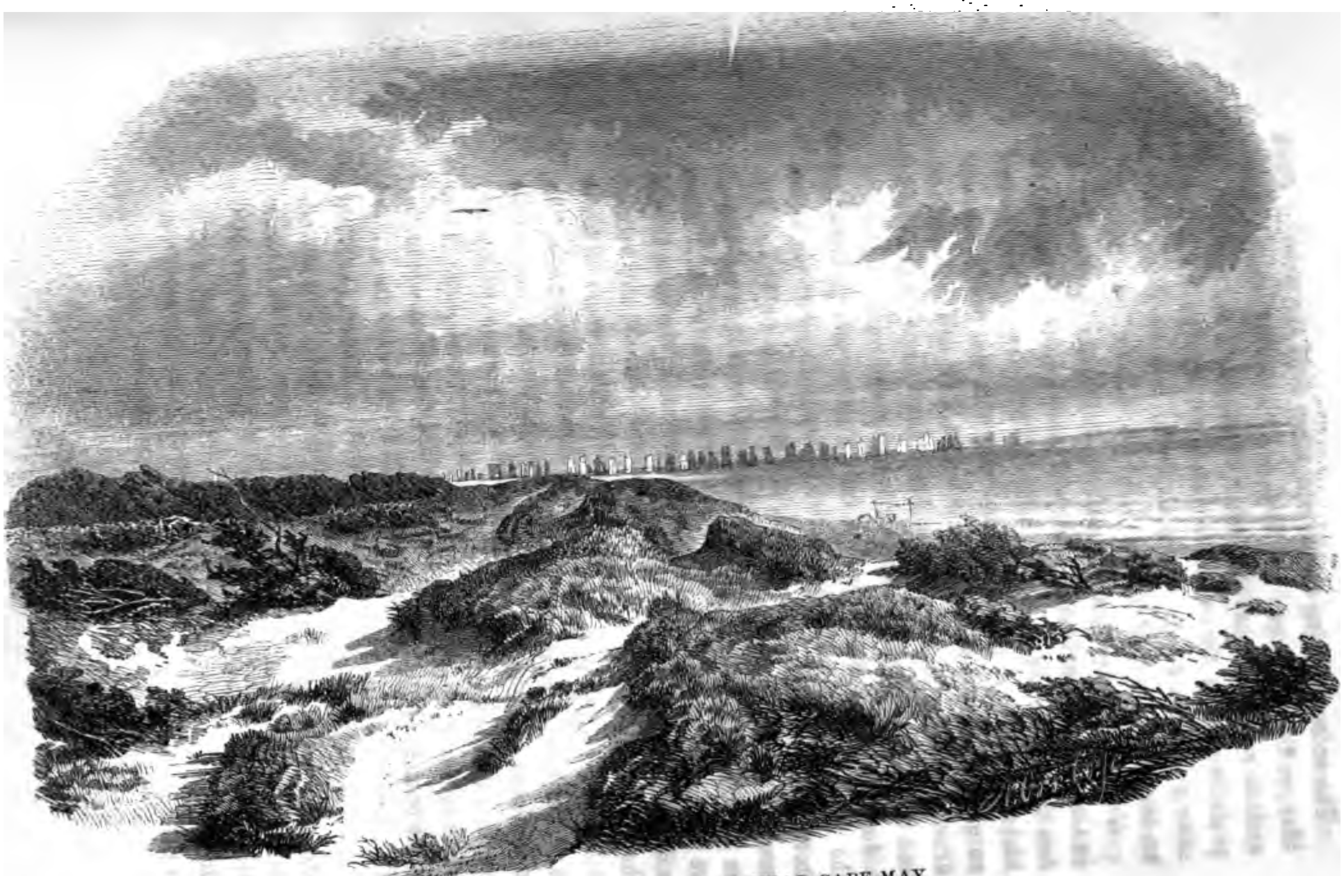
working, the stumps, roots, and turf, are removed from over the log, and the earth dug out. The trench which is thus made, of course, is full of water. There being no grit in the earth, tools can be used in it without injury, and the logs are rapidly sawn off by a one handled cross-cut saw, which can be worked directly into the soft earth. As soon as the log is cut off, and loosened by means of levers, it rises and floats in the water. It is then divided into shingle cuts, quartered, and thrown out to be split into shingles, and shaved; when it is ready for market. The annexed drawings show the different operations in this singular business. That in the swamp shows the floated log being cut into shingle lengths, and the shaving of shingles going on in the background. The view in the salt marsh shows the stumps still standing; also the operation of cutting off a log, preparatory to raising; and the splitting up of another log.

It is said that for five years past the average number of these shingles, sent from Dennisville, is not far from 600,000 a year. They are worth from $13 to $15 a thousand. About 200,000 white cedar rails have been sent from the same place this year. They are worth from $8 to $10 a hundred.

The view on the marsh was taken near Dennisville, looking towards Delaware Bay. It was just after a northeast storm, and the vessels seen are in Maurice River Cove, where they have run for shelter. It is said that as many as 500 vessels have been seen lying here at once, waiting for a change of wind. A breakwater is very much needed on the inside of Cape May; that at Lewiston, on the Delaware side, being insufficient for the number of vessels that need shelter. As it is now, many of the vessels going out the Capes, if met by a storm, put back and sail twenty miles up the bay to obtain a shelter, which should be found near the point of the Cape. Besides the loss of time in sailing so far back, the vessels in the cove are liable to be blown ashore by a change of the wind. A breakwater at the point mentioned would be of great advantage to our coasting vessels generally.

SAWING CEDAR-LOGS, AND MAKING SHINGLES.

RAISING, OR MINING, BURIED CEDAR TIMBER



VIEW FROM THE BEACH, NEAR CAPE MAY.

The acccompanying sketch was taken near the point of Cape May, on the bay-shore. It gives a good view of the sand-beaches, and the vegetation they support. It was taken the day after the preceding, when the wind had changed, and the vessels were sailing out of the bay. Cape Henlopen is seen in the distance on the right.

Gravel Bricks.—A new building material has been introduced in Cumberland, and some of the adjoining counties, which promises to be both cheap and durable. The common clean gravel and coarse sand of the country is mixed with one twelfth its measure of stone lime, and made into bricks. These bricks are sun-dried, and then laid up into walls. They are cheap, durable, and but little affected by the changes of the seasons.

In making, the gravel is laid on a common mortar bed—and the lime, which is slacked and made into a thin putty in a lime trough, is then run on the gravel, and the whole worked up into mortar. The bricks are usually made as large as is convenient for handling, and of dimensions to suit the work for which they are intended. The moulds are made, several in the same frame, as deep as the thickness of the brick, and without any bottom. They are set on smooth ground, and filled with mortar. This is worked in a little with the shovel, and struck off at the top. In ten or fifteen minutes the mortar will have set, so that the moulds can be taken off. The bricks are soon dry enough to handle, when they can be piled up, and allowed to dry thoroughly. They are laid in mortar similar to that from which the bricks are made, and the outside of the buildings is roughcast with the same.

The method was introduced at Bridgeton by Robert C. Nichols, Esq., manager of the Cumberland Iron Works. The accompanying cut is a view of Mr. Nichols' residence, which is made of this material. Several buildings of this kind have been erected in Bridgeton, and its vicinity, within the last eight or ten years; and in Norristown, Pennsylvania, it has been in use for seventeen years past. It has stood well, growing harder and more solid every

year. The bricks have come to be a regular article of manufacture in several places. Those of 12 by 9 by 6 inches were selling in Bridgeton, last summer, for $20 a thousand, and they could be laid, and mortar found, for $10 a thousand; which is less than half the cost of the same measure of red brick wall. The material of which these bricks are made being found almost everywhere, and the labor of making and laying them up very simple, farmers and others who have control of labor, can make and lay them at times when the expense of the work would not be felt, and thus a saving much greater than that mentioned could be made. When first laid up they are not quite as strong as other bricks; and greater care is necessary in making a solid foundation; otherwise unequal settling, and cracks in the walls, will result. Care must be taken to make them so early in the season, as to be entirely dry before the winter's frost.

Mr. Fowler, of New York, in his work entitled, "Gravel Wall Cottages, or Homes for all," has described a method of forming the wall directly from the mortar. It is done by setting up boards on their edges, where the wall is to be built, and as far apart as the thickness of the walls. The mortar is filled in between these, and allowed to remain till it has set, when the boards are raised to the top of this wall, and again filled, and so on till the wall is completed. This method, in the hands of experienced workmen, is undoubtedly cheaper than the other; but to unpracticed laborers would, as I believe, be attended with more difficulties. The material is used in the construction of houses, shops, stores, walls for gardens, yards, &c., for all of which purposes it gives entire satisfaction.

GEO. H. COOK,
Assistant Geologist.

Rutgers College, New Brunswick, Dec. 29, 1855.

Dwelling built of concrete bricks, Bridgeton, Cumberland Co.

REPORT

ON THE

GEOLOGICAL DEPARTMENT.

NORTHERN DIVISION OF THE STATE.

REPORT

ON THE NORTHERN DIVISION OF THE STATE.

The geological researches in the northern division of the State, have been chiefly confined to the azoic rocks of Sussex, Morris, and a part of Passaic and Warren Counties; all of which are embraced within the district known as the Highlands of New Jersey.

In reporting the progress of the geological researches in this district, I propose to give:

1. A general description of its physical features.
2. A general description of its geology.
3. Local details of its boundaries.
4. An enumeration and local details of its principal metalliferous deposits, showing, by means of sections, their geological position, and the extent to which the most important iron mines have been worked.
5. The art of mining, as applied to developing these metalliferous deposits.

PHYSICAL GEOGRAPHY.

The Highlands of New Jersey are composed of a series of parallel mountain ranges and hills, extending in a northeasterly and southwesterly direction, across the State, from the New York State line to the Delaware river.

This district, at the State line, is about twenty three miles wide, and reaches from the southeastern base of the Ramapo mountain and river, in Bergen County, to the northwestern base

of the Pochuck mountain, three quarters of a mile southeast of the Wallkill river, in Sussex County. Its widest part, which measures twenty-five miles, would correspond with a line drawn from the southeastern base of Mount Kimble, near Morristown, to the northwestern base of the Jenny Jump mountain. At the Delaware river its width does not exceed eight miles. Its average width may be stated at eighteen miles; its length at sixty miles; and its area at about one thousand and eighty square miles, or about one seventh of the whole State.

This series of hills, and mountain ridges, is a continuation of the Highlands of Putnam, Westchester, Rockland, and Orange Counties, in the State of New York; and presents the same general physical aspect, geological formation, and mineral products. Its physical features are entirely dissimilar to those of any other portion of the State, presenting, as is nowhere else done, a succession of mountain ranges, which do not run parallel with the general direction of the Highlands, but, ridge succeeding ridge, rising and disappearing one after another, cross obliquely the belt of these mountains. There are no continuous ridges exceeding a few miles in length, with the exception of the Green Pond mountain, the geological formation of which is different. The southwestern termination of these mountain ridges is generally steep and rugged; while their northeastern has a gentle or undulating slope, and disappears beneath the next succeeding ridge. This succession of ridges corresponds with the rocky strata and metalliferous deposits, and has been caused, undoubtedly, by dislocation of the strata, and lateral heaves of great masses of the rocky formation. Evidences of an elevating power acting from the northeast towards the southwest, as well as of a lateral power, are manifest throughout the whole extent of the Highlands. A true exposition of these would demonstrate the causes which have formed this succession of mountain ranges, and would be valuable, in an economic view, as serving to trace out the metalliferous deposits. I will, at this time, mention only

POCHUCK MOUNTAIN AND VERNON VALLEY, SUSSEX CO

a few of the principal series of mountain ridges, with their intervening valleys, in the counties of Sussex, Morris, and a part of Passaic and Warren, deferring a detailed description of them until the completion of the topographical map (now rapidly progressing,) which will represent, not only their relative positions with each other, but also with the whole belt of the Highlands.

MOUNTAINS.

Commencing with the northwestern boundary of this district, the different series of mountain ridges may be enumerated as follows:

1st. The series forming the Pochuck mountain, commencing with Mount Adam and Eve, in the State of New York, and terminating near Hamburgh, Sussex County. Rising again, a little northwest of Franklin Furnace, in the form of low, rounded hills, and sharp ridges, this series continues southwesterly to Andover, and includes Pimple Hill, Stirling Hill, the precipitous bluffs northwest of Sparta, and the Andover mountains.

The accompanying drawing, taken from the hills one mile east of Franklin Furnace, presents a view of Pochuck mountain and Vernon valley; and illustrates the characteristic features of the series of ridges, with their gentle inclinations towards the northeast, and their abrupt terminations towards the southwest, together with their general direction, as compared with the mountain belt described above.

2d. The range including the Wawayanda, Wallkill, Hopatcong, and Schooley's mountain, rising in some places to the height of seven or eight hundred feet above the adjoining valleys.

On the summit of this mountain range are numerous lakes, ponds, springs and swamps, including the Wawayanda and Hopatcong, Norman and Senecawana lakes, hereinafter described, as well as the celebrated Chalybeate spring of Schooley's mountain.

3d. The Green Pond mountain range, which differs from the

others in being one long, narrow, and almost uninterrupted ridge, from Succasunna plains to the State line, and which, being of a different geological formation, affords a striking contrast with the irregular and broken outlines of the adjoining belt of hills of azoic rocks.

4th. The Ringwood, Copperas, Splitrock, Hibernia, Mount Hope, Mount Pleasant, and Mount Ferrum mountains, a range differing from the others, in that it contains the principal iron mines of the Highlands.

5th. The series forming the south-eastern boundary of the Highlands, and which includes the Ramapo, Pompton, Boonton, Trowbridge, Washington, and Kimball mountains.

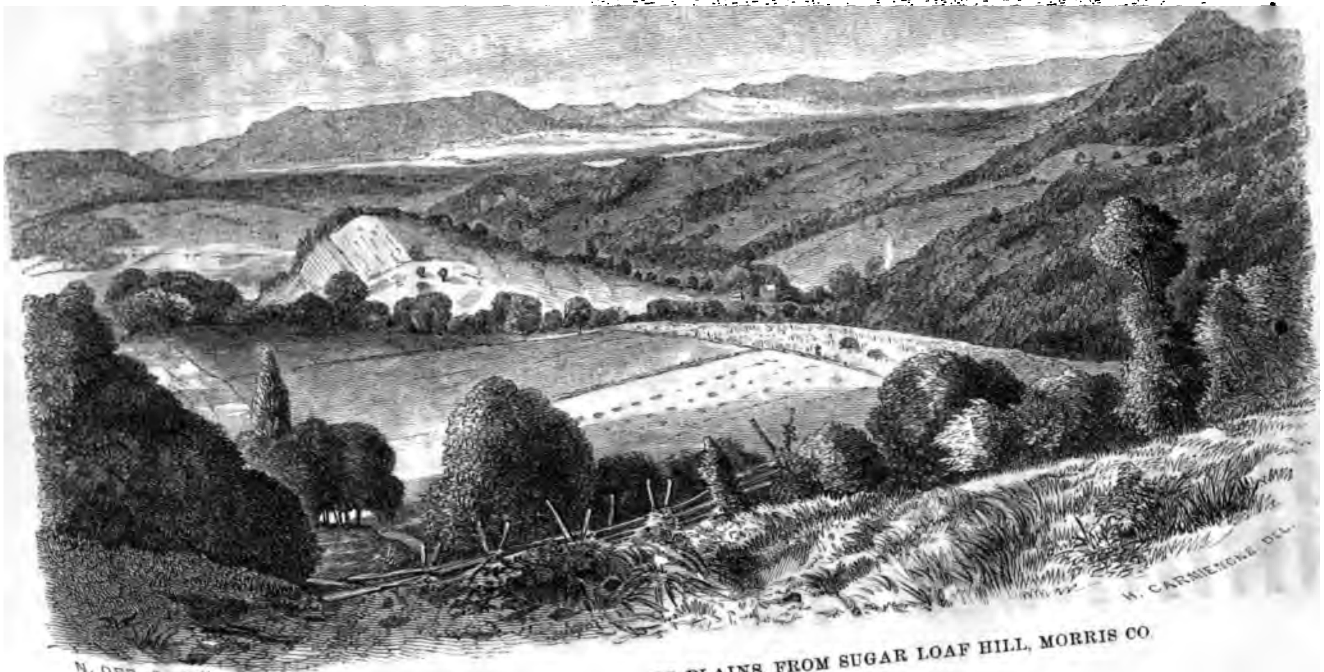
The annexed drawing, taken from Sugar Loaf hill, two miles and a half west of Morristown, gives a view of a part of this boundary, and especially of the Trowbridge mountain. The same general features of the ridges, their direction, outline, slopes, etc., are seen here, as at the northwestern boundary—the Pochuck range.

The foreground, to the base of the mountain, represents Watnong plains, (Morris plains) with their undulating surface, and low, rounded hills of drift, and disintegrated gneiss. The bold, elongated summit at the left, is the Watnong mountain—a spur of the Trowbridge mountain.

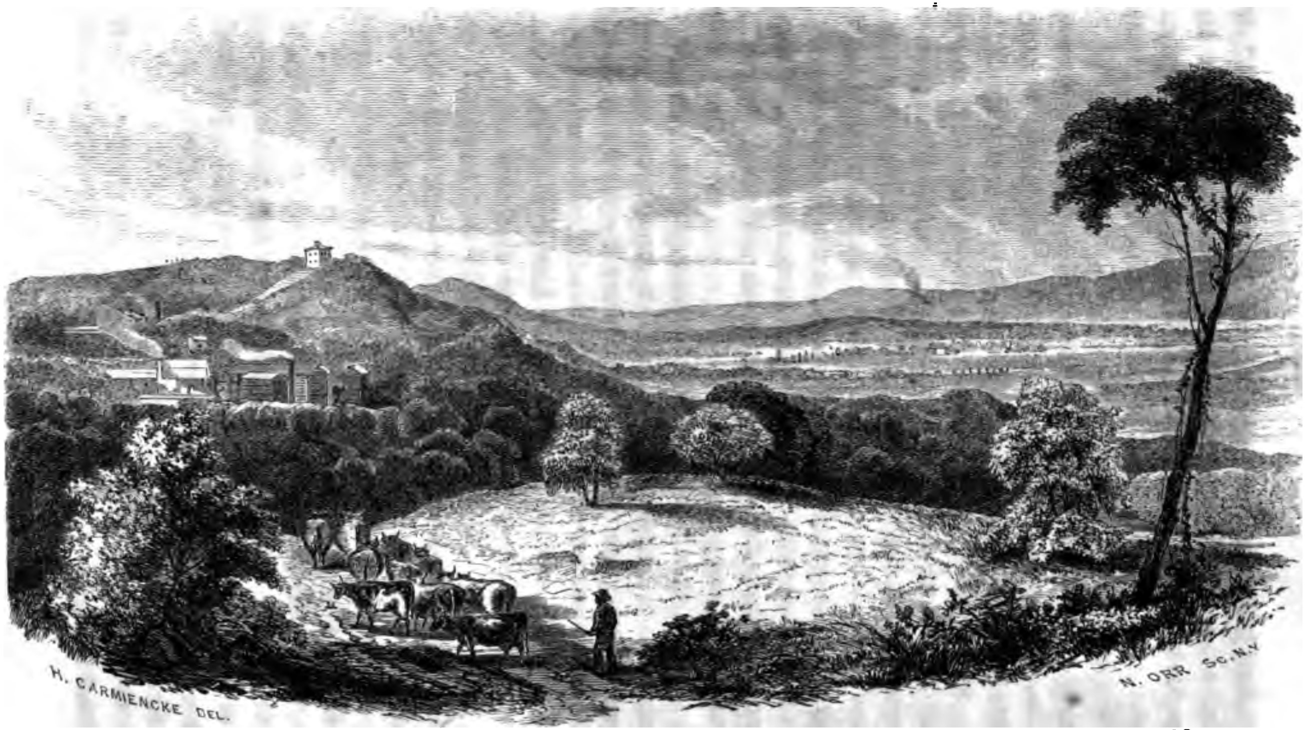
VALLEYS.

Parallel with the mountain ranges are numerous intervening valleys, varying in length, from one to twenty, and thirty miles, which being enumerated in the order just observed in naming the mountains of this district, are:

1st. The most north-westerly, within the Highlands, the Vernon and Wallkill valleys, which extend from the State line to the head waters of the Wallkill river, about three miles southwest of Sparta. It is bounded on the north by Pochuck mountain, and Pimple Hill range, and on the southeast by the Wawayanda, and Wallkill mountains.



TROWBRIDGE MOUNTAIN AND WATNONG PLAINS, FROM SUGAR LOAF HILL, MORRIS CO.



MOUNT FERRUM, SUCCASUNNA PLAINS AND SCHOOLEY'S MOUNTAIN, FROM RANDELL HILL, MORRIS CO.

This valley varies in width from a half to two and a half miles; its greatest breadth being near the State line. Its northeastern, or Vernon portion, is drained by the Wawayanda and Black creeks; its southwestern, or Wallkill portion, by the Wallkill river.

2d. Greenwood valley, situated in Morris County, between the Wawayanda and Greenpond mountains, seven miles in length, and drained by Belcher's creek and Greenwood lake.

3d. Longwood and Berkshire valleys, in Morris County; bounded on the northwest by the Wallkill and Hopatcong mountains, and on the southeast by the Greenpond mountain; from half a mile to one mile in width, twelve miles in length, drained by the Rockaway river, and possessing a rich and fertile soil.

4th. Succasunna plains, which is a continuation of the same valley, towards the southwest, being from two and a half to three miles wide, and six miles long.

This valley is bounded on the northwest by Schooley's mountain, and on the southeast by Mount Ferrum. It has a light, sandy, and gravelly soil, and is drained by the Black river. The accompanying view, taken from Randall hill, about one mile from McCainesville, on the turnpike leading to Dover, represents, near the foreground at the left, the Dickerson and Byram mines, situated on Mount Ferrum, and, in the background, the Schooley's mountain range, with the Succasunna plains intervening.

5th. German valley, about ten miles long, and from one to two and a half miles wide.

This valley is bounded on the northwest by Schooley's mountain, and on the southeast by a mountain ridge, rising at the southwestern part of Succasunna plains, and separating it therefrom. It is drained by the south branch of the Raritan river, and possesses a fertile soil.

6th. Green Pond valley, which lies at the base of the Green Pond mountain.

This valley extends from Charlottenburg to Mount Pleasant. It is about eleven miles long, from one-half to one and a half miles wide, and is drained by the Green Pond (Burnt Meadow) brook.

7th. Beachglenn and Splitrock valleys, which lie between two ranges of mountain ridges, extending from Rockaway to Durham, and designated as the Hibernia and Splitrock mountains.

The length of these valleys is nearly ten miles, and their width varies from a half to one and a half miles. They throw off several minor valleys, corresponding with the tributaries of the Beaver and Beachglenn brooks, which flow through their principal parts, affording an excellent water power, that has been made available for more than a century, in driving forges for the manufacture of iron from the ore of the adjacent mines. The hills upon either side rise from fifty, to six hundred feet above the trough of the valleys; and their peculiarly precipitous southwestern extremities, with their oblique direction to the general course of the valleys, and the many dislocations of the rocks, produced here by powerful perpendicular and lateral heavings, unite to afford that wild and picturesque scenery so characteristic of the Highlands. The surface is level, or gently undulating; contains large deposits of peat and muck, and affords a rich fertilizer for their loamy soil.

9th. Rockaway, Den, and Indian Brook valleys, which lie in Morris County, along the same general range of mountains, and from one to three miles southwest of the last described valleys.

These valleys extend from the vicinity of Bloomingdale, at the Passaic County line, southwesterly to Denville, Walnut Grove, and Mendham, and thence to the Somerset line. They vary from deep gorges to level and undulating plains, of one and two miles in width. The first two are drained by the Rockaway river and its tributaries, which divide into numerous rivulets and brooks corresponding with the minor valleys, extending to some distance between the spurs of the mountain ridges. The last

mentioned is drained by several small tributaries of the Whippany river, as well as by one of the branches of the Raritan.

10th. Lubber's valley, which commences in the south-western part of Sparta Township, near the source of Lubber's run, and continues in a southwestern course to its junction with the Musconetcong river, a distance of about eight miles.

This valley varies from one to three-fourths of a mile in width, and is, for the most part, low and comparatively level, containing a large area of marshy lands. The slightly elevated portions in the upper (N. E.) part, as well as the slopes of the hills between which the valley lies, are generally cultivated, and comprise the greater share of the tillable land in Byram Township. On the southeast, it is bordered by the continuation of the Wallkiil mountains, and on the northwest by the elevated lands extending northeast from the Alamuche mountains.

11th. Ringwood valley, which commences at the State line, and, extending in a southwesterly direction to Winoke, a distance of seven miles, deflects southward nearly to Pompton, where it expands, and forms what are called the Pompton Plains.

The whole length of this valley is ten miles, and its width varies from three-eighths to one mile. It lies between rough and irregular hills and ridges, from seventy-five to one hundred and fifty feet in height, and is drained by the Ringwood river and its minor tributaries. The surface is undulating throughout its whole length, except through Winoke, where, for a distance of two miles, it is remarkably level.

LAKES AND RIVERS.

Throughout all nature there is nothing, perhaps, more interesting, and, withal, more simple, than the means employed for irrigating and fertilizing the earth. Observation shows us that the clouds gathering around and above the summits of the mountains, pour upon them their waters, which, collecting in depres-

sions, form ponds and lakes, or, percolating in the fissures of the rocks, burst forth in springs, or, flowing into ravines, form rivulets, which unite and swell into rivers, and finally empty into the ocean, the great receptacle of waters, to pass again into the atmosphere, and again to visit the mountain tops and valleys.

The drainage of a district of country by its water courses, has not been inaptly compared to the circulation of the blood in the human body. As the impure blood from every part of the body is conducted by means of the veins to its great receptacle, the heart, and thence to the lungs, to be purified, and again distributed throughout the whole system, so the impure water from every mountain, valley and plain, is carried, by means of rivulets and rivers, into the ocean, where it is purified and again distributed to every portion of the earth.

The Highlands form the great water slope of the northern and central portions of the State. The principal lakes of this district are situated upon the mountain summits, whence springs burst forth on every hand to form its principal rivers.

The Wallkill river.—Following the arrangement that was observed in the forgoing enumeration of mountains and valleys, we begin, in speaking of rivers, with the most northwesterly of the principal streams, which is the Wallkill river.

This river rises in Byram Township, Sussex County, and flows in a north-northeasterly direction, through the village of Sparta, and thence between the Wallkill mountain and the Pimple Hill range, through Hardiston Township. Thence taking a southeasterly course to the State line, it forms the boundary between Wantage and Vernon, and completes a distance of twenty-three miles in the State of New Jersey. From the State line, it continues its northeasterly course to the Hudson river, into which it empties about three miles from Kingston. From its source to Sparta, it passes, for the most part, through low, marshy lands; and at Sparta its volume is much augmented by a stream which

enters it from the east, and which furnishes, at a number of places in and near the village, available water-power, that is employed in driving forges, flouring, and saw-mills. Passing thence to Franklin Furnace, the fall of the stream is not very great; and, indeed, two miles of this part of its course is over very low lands. But at Franklin Furnace an excellent water power is again afforded; and the stream is still further increased by several tributaries, which take their rise in, or at the base, of the Wallkill mountain. Between Franklin Furnace and the State line, the volume of the stream is once more increased by a number of tributaries, but its fall is insufficient to furnish good water power, except at Hamburg. Its principal tributaries below Franklin Furnace, are Nova Scotia brook, a stream flowing from Mud Pond, upon the Hamburgh mountain, Beaver creek, flowing into it about two miles below Hamburgh, and Papakating river, a stream of inconsiderable magnitude, rising in Frankford Township, and flowing into it about one mile and a half southeast of Deckertown. From the point where the turnpike from Deckertown, through Hamburgh, crosses the stream, it flows over low, marshy lands, known as "the Drowned Lands," which have a length of nine miles, and an average width of two thirds of a mile, and which cover an area of nearly four thousand acres. These lands are about three hundred and twenty-five feet above tide water in the Hudson river, and twenty feet lower than the Delaware river at the State line. The greater portion of them is covered with a dense growth of maple, white birch, and underbrush; and, except to a small extent along their borders, and upon Chandler's Island, these lands are wholly uncultivated. They consist of deposits of peat and muck of dark brown and black colors, well decomposed, and increasing in depth towards the centre. They are subject to annual overflows, and during a portion of the winter and spring are inundated by the backing of the water of the Wallkill from a point about ten miles below the State line. Through these lands, the current of the river is

scarcely perceptible; its width here is from forty to ninety feet, and its depth from three to six.

THE PEQUEST RIVER.—This stream is formed by the union of four distinct branches, which rise in the south southeastern part of Sussex County. The west branch, originating in a limestone cave on the farm of Samuel Hunt, Esq., in the township of Green, flows thence in a northeasterly direction to Springdale, where it deflects to the southeast, uniting with the east branch at Huntsville. The east branch is formed by the confluence of three minor branches, one of which has its source in a pond near Pinkney's Corner, another between Andover and Sparta, and the third in Panther Pond. From Huntsville to the Warren County line, the Pequest flows in a direction nearly parallel with the base of the northeastern continuation of the Alamuche mountain; and from the county line it pursues an irregular southwesterly course to Belvidere, where it empties into the Delaware river, about thirty miles from its source. This stream flows through a rich and productive section, varying much in appearance. The two branches, rising respectively in Green Township, and near Pinkney's Corner, pass through low, marshy lands, while the other two branches pass over rough and hilly districts, affording excellent water power in several places.

Between the county line and Long Bridge, the Pequest drains a large extent of marshy land; and between Long Bridge and Danville, it flows through the "Great Meadow," an uncultivated tract which covers an area of about five thousand acres.*

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* The following is an extract from a letter of Geo. Green, Esq., upon the subject of the drainage of these lands; and upon an examination and report thereon:

"This subject would be a legitimate one for such a report, and the drainage could be suggested or recommended on public ground that would be incontrovertible. I should think that the State, County, Township, and the community in this vicinity, would all be benefitted by the bringing into profitable cultivation so large a tract of comparatively worthless land, and making it one of the most valuable and productive in the State."

As soon as detailed examinations are extended to that portion of the State, the subject will be thoroughly investigated.

Between Danville and Belvidere, however, it passes through a more hilly district, and the fall of water at several places, especially at Belvidere, is very considerable.

MUSCONETCONG RIVER.—This stream, originating in Hopatcong lake, flows through the canal reservoir to Stanhope, and thence in a west southwesterly direction to Waterloo, where, turning, and passing through the Musconetcong valley, it pursues a southwesterly course to the Delaware river, forming the boundary line between the counties of Sussex and Morris, as far as Byram, one mile below Waterloo. From this point to another, one mile below Stephensburg, it forms the boundary between Morris and Warren; and thence to its mouth, the boundary between Warren and Hunterdon counties. Its length is little less than forty miles. A large number of minor streams flow into it, the principal of which is Lubber Run. Its fall between Hopatcong lake and Waterloo, is sufficient to afford excellent water power at several places. Between Waterloo and Hackettstown, it passes into, and out of, the canal at a number of places, flowing through two or three marshy tracts of land. From Hackettstown to its mouth, it has, also, fall enough to furnish good water power. The land upon either side of it, through the Musconetcong valley, is generally cultivated; and the soil is very rich and fertile.

PASSAIC RIVER.—This river, remarkable for being the longest and most circuitous in the State, as well as for the varied and beautiful scenery through which it passes, over every variety of surface, sometimes in the form of rapids, cascades, and precipitous falls, and at others, with scarcely a ripple to indicate its course, takes its rise near Mendham, in the Highlands of Morris County, and flows in a south by south-easterly direction, with such rapidity, as to afford available water power for a distance of ten or twelve miles, to Stony Hill. Here it receives the water of Dead river, and, turning suddenly, flows in a north-

easterly direction, along the southeast base of the range of hills designated as Long Hill, and thence along that portion of the continuation of the same range, known as the Short Hills, to Canoe brook. After flowing in a northwesterly direction, for somewhat more than a mile, it pursues a northeasterly course, over a level tract of meadow and marshy land, to Pine Brook, one mile and a half below its junction with the Rockaway river. Thence it takes a circuitous course along the base of the Towackhow mountain, for a distance of thirteen miles, to the Two Bridges, at its junction with the Pequannock river. From this point, flowing to Little Falls, it is intercepted by a dike of trap rock, which, crossing it, forms a natural dam, over which, for half a mile, the water falls fifty feet, forming small cascades and rapids. Then, flowing in a southeasterly direction to Paterson, it is again intercepted by a trap dike, forming the Passaic Falls, seventy feet in height. About one and a half miles below this point, it turns suddenly, and, flowing first in a southerly, and then in a southwesterly direction, it passes through Acquackanonck, Belleville, and Newark, and empties into Newark Bay.

In the southern part of Morris County, this river and its tributaries pass over two large tracts of meadow, marshy lands, occupying an area of twenty or thirty thousand acres. So level is the surface of these lands, that the river flows through them with a sluggish and almost imperceptible current, overflowing, at certain seasons of the year, vast numbers of acres lying upon its borders.

One of these tracts of meadow land, known as the Great Swamp, is situated on Black creek, between Chatham and Baskingridge. Not long ago a dense forest covered its whole surface; while, at present, a large portion of it is well timbered, other parts are covered with alluvial matter, to the depth of several feet, wherein are imbedded numberless limbs and trunks of trees. The greater part of this tract, having been cleared and drained, affords, in its higher portion, a rich soil of a sandy

loam, and in its lower portion, meadow lands of great value. The whole of it, being rendered available by means of drainage, for which it possesses sufficient fall, might become the most productive arable, and meadow land in this section of the country.

The other tract includes the Columbia, Whippany, Hanover, and Troy meadows, embracing an area of 10,000 or 15,000 acres. During the winter season the greater part of these lands are inundated; and these inundations frequently continue until so late a period in the spring, and even summer, that crops of great value are totally destroyed. But these inundations, in addition to rendering the lands entirely valueless, often leave large pools of stagnant water, which, under the influence of the summer sun, generate marsh effluvia, and, consequently, intermittent and remittent fevers.

The principal causes, both direct and indirect, of the frequent inundations of these lands are: 1st. The dike of trap rock at Little Falls, which intercepts the stream, and causes a back water for some distance. 2d. A bar formed (as far as examination has been made,) of sand, gravel, and boulders, (some of which are of gneiss, and from ten to fifteen feet in diameter,) at the Two Bridges, where this river receives the waters of the Pequannock. During the time of a heavy freshet, it is said that the back water extends up the Passaic a distance of eight or ten miles above the bar; and pieces of timber that have been seen floating down the Pequannock river, have been afterwards found ten miles above, in the Passaic. 3d. Bars are formed in the Passaic, near its junction with the Rockaway river, by the deposition of the sediment brought down by the Rockaway, Whippany, and Parsippany rivers. These sedimentary deposits, which are yearly increasing, together with an accumulation of a rapid and bountiful growth of plants, the two principal of which are, according to Prof. Cook, *Valisneria spiralis*, and *Potomogeton panciflorus*, choke up the passage, and cause the stream to become sluggish, and more liable to overflow its banks. During the last forty or

fifty years, the river has filled up to so great an extent, that lands, formerly dry and arable, are now inundated for a great portion of the year.*

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* It is evident that, if these lands should be thoroughly drained, they would become the most productive and valuable arable and meadow lands in this section of the State. Drainage would also have a tendency to render this whole district, and its vicinity, more healthy, by removing, in a great measure, the cause of the intermittent and remittent fevers, which prevail here, so generally, at certain seasons of the year. Little has yet been done for the accomplishment of this, although various plans have been proposed; and among them, the removal of the trap dike which intercepts the river at Little Falls, the removal of the bar at the Two Bridges, and the dredging out of the river, so as to remove the principal bars and obstructions. In 1834, Mr. R. B. Mason, civil engineer, was employed to make a survey of the river, from Chatham to Little Falls, and to report on the most feasible plan of draining the meadows bordering thereon. The report made by him was in substance as follows:

"*An account of fall in the Passaic River, from Baldwin's Bridge, above one mile north of Chatham, to Little Falls:*

	FEET.	INCHES.
From Baldwin's bridge to Dickerson Place - - -	0	¼
" Dickerson's Place to New Turnpike - -	2	2
" New Turnpike to Cook's bridge - - -	0	4
" Cook's bridge to Swinefield's bridge - -	0	8½
" Swinefield's bridge to Pine Brook - - -	1	8
" Pine Brook to mouth of Deeparaal creek - -	6	9
" Deeparaal creek to reef of rocks - - -	0	3
" Reef of rocks to top of Miller's dam - -	0	8
Whole fall, from Baldwin's bridge to top of Miller's dam,	12	1¾

This river, from Pine Brook to the mouth of Deeparaal creek, a short distance above Little Falls, pursues a very circuitous and winding course of near fifteen miles, with a fall of only five and a half inches to the mile, and with many abrupt and sudden bends—its banks constantly forming impediments to the rapidity of its current, or, in fact, almost destroying it, while in a direct course from Pine Brook to the mouth of Deeparaal creek, the distance is only three and three-quarter miles, with a fall of more than twenty-one inches to the mile, or nearly seven feet in the whole distance. If a canal or ditch should be opened from Pine Brook to the mouth of the said creek, to divert a part of the water of the Passaic from its present course, it would make a passage for the water, having nearly four times as

Tributaries of the Passaic.

PEQUANNOCK RIVER.—This river rises in the Wawayanda mountain, and flows in a southeasterly direction, six miles to Morris County, whence, forming the boundary between Morris and Passaic Counties, it pursues a tortuous and rapid course through Stockholm, Newfoundland, Charlottenburgh and Bloomingdale, to Pompton Plains. Throughout the whole of this course it affords numerous and excellent mill sites, many of which are occupied for forges and other purposes. At Pompton, it receives the waters of the Ringwood and Ramapo rivers, the former of which rises in the State of New York, and flows through Passaic County, a distance of ten or twelve miles, in a southwesterly direction. From Pompton it proceeds, for the most part, with a sluggish current, through a level and undulating country, to the Two Bridges, at its junction with the Passaic river.

ROCKAWAY RIVER.—This river rises in the Wallkill mountains, in Sussex County; and thence pursuing a tortuous course through Russia and Milton to Petersburgh, it deflects to the southwest; and, keeping that direction to the line between Roxbury and Jefferson Townships, a distance of about nine miles, takes a southeasterly course to Dover, whence, in a northeasterly direction, it proceeds to Rockaway. From Rockaway, it flows in an easterly direction to Denville, where it resumes its northeasterly course to the distance of about one mile above Powerville. Here it turns towards the south-southeast, a di-

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much fall to the mile, with one-fourth of the distance to run; and, on account of the ditch being in a direct line, the nature of its banks would still less reduce the obstacles to be overcome by the curve. This would relieve thousands of acres, now covered with water for a great portion of the year, and would give valuable returns to their owners."

When the detailed topographical and geological survey shall have been completed, the most feasible plan for draining these meadows may be determined.

section which it very nearly maintains to the Passaic river. Its whole length is about forty miles; and its course, except through Longwood and Berkshire valleys, is remarkably irregular. The principal sources whence this river derives its supply, are, Green Pond, Beach glenn and Den brooks, together with two streams about six miles in length, one emptying into it about a mile above Powerville, and the other about three miles below Boonton, and the Whippany river. Excellent water power is furnished along the greater part of its course, and, at numerous places, this power is employed in driving forges and other iron works.

Whippany River.—The Whippany river takes its origin in a number of small rivulets which find their way chiefly from the southeastern slope of the Trowbridge mountains, in Mendham, and Hanover Townships. These rivulets form two principal streams: which, after draining Watnong plains, and affording a number of excellent mill sites, unite at the head of Speedwell Lake, and thence flow in an east northeasterly direction through Morristown and Whippany, still furnishing the best facilities for manufacturing purposes. The single stream, which is thus produced, after passing through Whippany, crosses Columbia and Troy meadows, with a sluggish, almost imperceptible, current, and empties into the Rockaway river, about one mile above its junction with the Passaic. The numerous lakes and ponds formed in its course, give great variety to the scenery, and add much to the advantages of the surrounding country. Upon their banks and shores, numerous private residences may be seen, embellished equally by nature and art, and regarded as among the most charming and healthy residences in the Highlands. (See view of Speedwell Lake.)

Parsippany River.—This stream —a tributaryof the Whippany river—rises in the Trowbridge mountains, in Hanover Township, Morris County, and flows in a southeasterly direction, through the rich agricultural districts of Parsippany and Troy,

and thence, crossing the Troy meadows, empties into the Whippany river, one mile above its junction with the Rockaway river. This stream is ten miles long, and has a considerable fall from its source to the village of Troy. But, in addition to the Whippany and Parsippany rivers, which flow through the places bearing these names, as well as through Troy, there are numerous small tributaries, having their source in the continuous springs, bursting every where from the slopes of the hills, which not only afford admirable facilities for enriching the uplands and more elevated portions by irrigation, but which render the whole district one of the most noted in the State for grazing.

LAKES OF THE HIGHLANDS.

The Highlands of New Jersey are remarkable for a large number of beautiful lakes and ponds of fresh water, varying, in length, from one to five and a half miles. According to the plan of this report, no further description of them is attempted, however, at this time, than that which necessarily accompanies an enumeration of those most worthy of remark. They may be mentioned as follows:

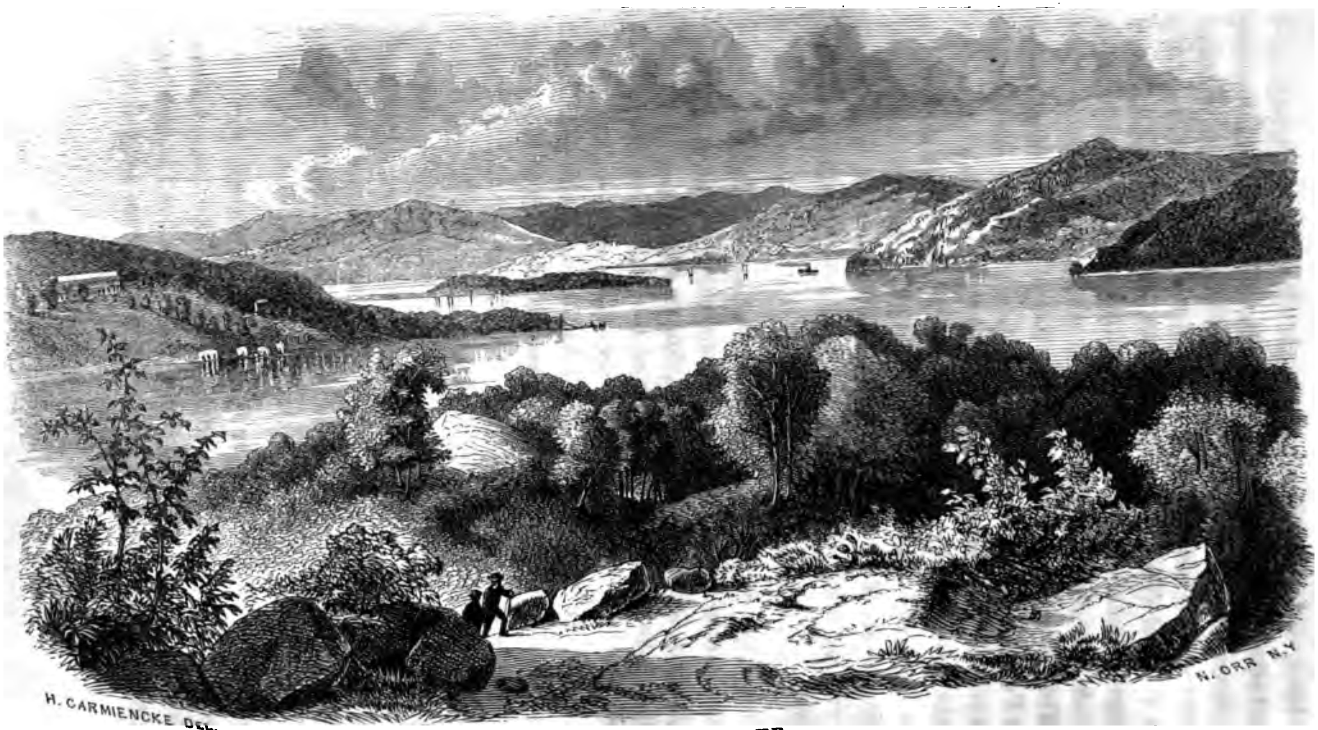
1st. WAWAYANDA LAKE, situated upon the summit of Wawayanda mountain, about eight hundred feet above the level of the Wallkill river, and about one-third of a mile west of the Wawayanda Furnace.

This lake is about one mile and two-thirds in length; and is formed by the junction of two ponds, which have been made by the building of a dam near the "Furnace." The north northeasterly of these ponds is about two-thirds of a mile in length; the other, a little more than three-quarters of a mile in length; and the two are connected by a channel about one hundred yards wide, and one-quarter of a mile long. Their average width is about three-eighths of a mile; and both of them are contracted by a point of land jutting out from the eastern side. At their extremities, the water is quite shallow, but in some places it has

a depth of eighty feet. The supply is chiefly from two or three small streams, which have their origin in swamps upon the mountains; also from springs within the limits of the ponds themselves. The motive power employed at the Wawayanda Furnace, as well as at the mills located here, is furnished by these waters. Around them the hills rise to the height of fifteen to forty feet, with a slope varying from five to eighteen degrees; and while in some places the shores are rendered very rough by the outcropping of rock, in others they are comparatively smooth. Neither the shores, nor the hills, have yet been subjected to the hands of the cultivator, and they are still covered with a dense growth of different varieties of oak, together with chestnut, hickory, and various kinds of shrubs. The waters formerly abounded with Lake Salmon trout (Salmo confinis), weighing from six to eight pounds; large, yellow perch (Perca flaviscens), pickerel (Esox reticulatus), and other fish; but within the past few years, they have become less abundant.

2d. Hopatcong Lake, the largest in the State, and situated on Hopatcong mountain, between the counties of Morris and Passaic.

This lake is five and a half miles in length, and varies from one-third to one and three-quarter miles in width. It is the principal feeder of the Morris Canal, being at its summit level, an elevation of nine hundred and twenty-one feet above New York Bay, and seven hundred and sixty feet above the Delaware river at Easton. It is navigable for vessels of one hundred tons burden. In some places, its shores, formed of precipitous rocky bluffs, are very irregular; in others, long, narrow points of land stretch almost across it, forming numerous inlets and coves. It contains two islands—one towards its upper, or northwestern extremity, about one mile and a half in circumference, called Halsey Island; the other, formed of gravel and sand, about three-quarters of a mile in circumference, rising forty feet above



HOPATCONG LAKE.

its level, and called Canfield Island. It is fed by numerous small streams, which, originating in the springs of the surrounding mountain slopes, find their way to it through gullies, deep gorges and ravines. It abounds with fish; the principal of which are pickerel (Esox reticulatus), perch (Perca flaviscens), eels (Anguilla tenuirostris), cat fish (Pimelodus catus), which, at certain seasons of the year are taken in large numbers.

The accompanying cut presents a view of the lake from Tempys Point, looking towards the northwest. The characteristic features of the mountain ridges of the Highlands are pictured in the background; and the general formation and character of a Highland lake are very well exhibited by the low projecting points of the land, bluffs and mountain spurs, with their intervening coves, forming the banks, and surrounding Canfield Island.

3rd. Lake Senecawana, or Budd's Lake.—Situated in the central part of the Highlands, about six miles southwest of Lake Hopatcong, in Roxbury Township, Morris County.

This lake is celebrated as one of the most beautiful in the Highlands of New Jersey, and as occupying one of its healthiest localities. It is about three and a half miles in circumference, being supplied, chiefly, by the numerous rivulets formed from the springs of the gentle slopes surrounding it; and serving, itself, as one of the principal sources of the South Branch of the Raritan river. Its waters, remarkably clear, and well stocked with pickerel, (*Esox reticulatus*,) perch, (*Perca flaviscens*,) and various other kinds of fish, offer inducements to the lovers of piscatory sports, rarely found in any other section of the country.

4th. Greenwood Lake, or Long Pond—Situated partly in Passaic County, of this State, and partly in the adjoining State of New York. Its whole length is between seven and eight miles, of which, about three miles are within the territory of New Jer-

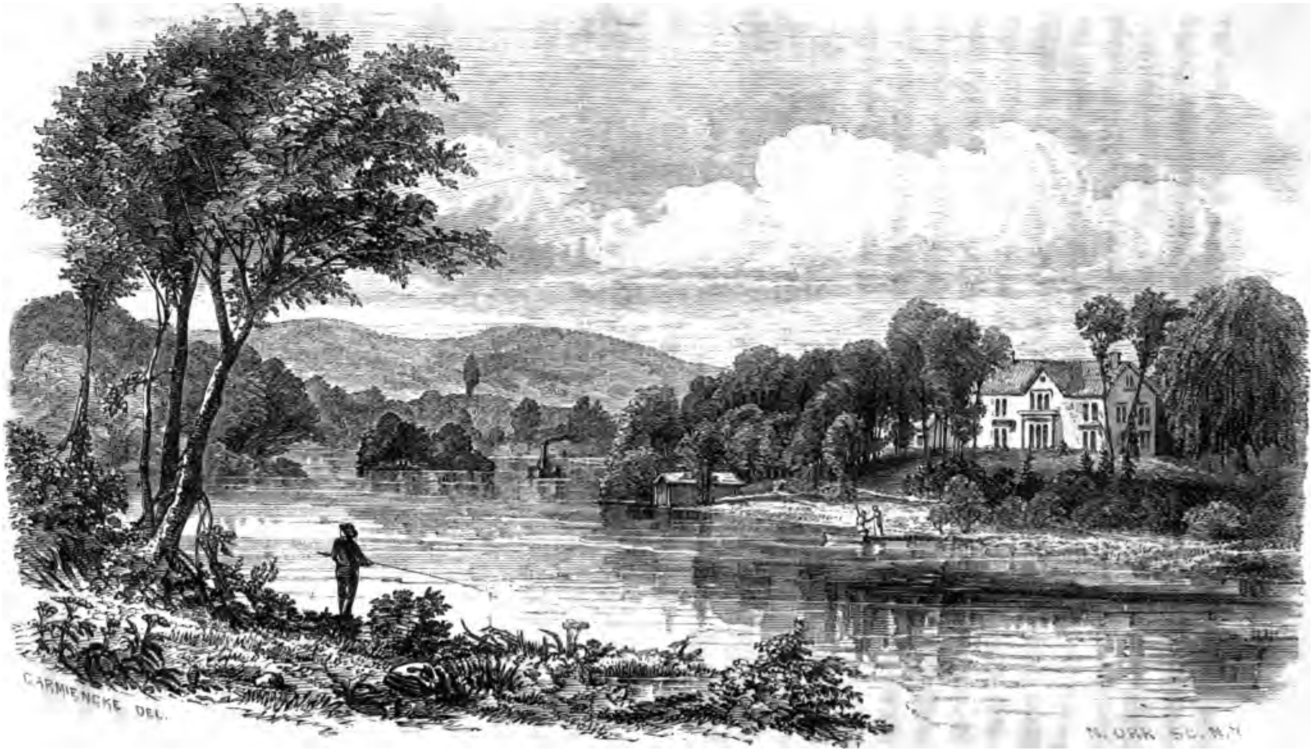
sey. Its width varies from one third to one half of a mile. Two parallel ranges of hills, varying from thirty to seventy-five feet in height, rise upon either side of it, with slopes of 10 deg. to 40 deg., and covered with trees, consisting principally of oak and chestnut. The depth of its water increases gradually from its southwestern to its northeastern extremity. The extreme southwestern portion was a swamp, until, by damming up its outlet, the water was made to rise. This outlet is from fifteen to thirty feet in width, and has quite a rapid current, while the streams flowing into the lake, with the exception of two, one of which is Belcher's creek, are very insignificant. This lake has long been a favorite resort for those who find pleasure in angling. Pickerel, (*Esox reticulatus*) and many other kinds of fish, are here found in great abundance.

5th. GREEN POND—Situated between the Green Pond and Copperas mountains, in Morris County.

This is a beautiful sheet of water, about two miles and three quarters in length, and from one quarter to two thirds of a mile in width. Its water, derived from springs quite near its border, is very clear and deep. Green Pond brook, its outlet, flows into the Rockaway river, near Washington Forge. On the northwest side, strata of conglomerate and sandstone rise, in the form of perpendicular bluffs, to the height of twenty, and sometimes forty feet. On the southeast side, the hills are comparatively smooth, sloping towards the water, at an angle varying from 10 deg. to 35 deg. The land in the vicinity, except at the northeastern end, where a portion is cultivated, is covered with a growth of chesnut, oak, and other trees, and underbrush. The pond abounds in pickerel, perch, and other fish.

6th. SPEEDWELL LAKE—Another beautiful sheet of water, lying in the course of the Whippany river, at the northwestern extremity of the Washington mountain.

This lake is about two miles in circuit, and is surrounded, in



SPEEDWELL LAKE.

part, by gently inclining hills, whose slopes are covered with a luxuriant growth of oak, hickory, and chestnut. The cultivated lands in the vicinity are exceedingly fertile, and the banks furnish most admirable sites for private residences. The accompanying view is taken from the shore opposite to the dwelling of Hon. George Vail. In the background are seen the Trowbridge mountains, between which and the lake are the Watnong Plains. It will serve to illustrate the general character of the scenery bordering upon the lakes, ponds, and streams in this vicinity; the beauty of which, together with the healthfulness of the climate, and the facilities for communicating with New York city, render the district a desirable one for private residences. Already it is somewhat noted in this respect; and elegant and commodious mansions are beginning to stud the borders of the lake.

GEOLOGY.

The geological formation of the Highlands is chiefly comprised within that system of rocks, designated, at the present day, as the *azoic system.* This system is composed of sedimentary rocks, and is destitute of organic remains.

In that portion of the Highlands under consideration, the following varieties may be mentioned, as of most general occurrence, the reader being, at the same time, referred to the local details in this report, for their particular location.

1st. Gneiss.

2d. Hornblende, micaceous, feldspathic, and quartzose schists.

3d. White crystalline limestone, (saccharoidal marble,) interstratified with seams, or layers, of magnetic iron ore, (magnetite,) and iron pyrites.

T ese rocks, interstratified in various ways, occur in distinct belts, or mountain ranges, the slopes of which are, in some instances, flanked with palæozoic rocks. They are traversed by numerous intrusive dikes of granite and syenite, the general di-

rection of which is northeast and southwest. The strata are highly metamorphic, rendering them crystalline, and subcrystalline in structure. They exhibit violent dislocations, being displaced vertically, laterally, contorted, folded, etc. Their general strike is northeast and southwest, and their dip southeast. They are traversed by joints, the general direction of which is at right angles to the line of strike. And in addition to their distinct stratification, and system of joints, they exhibit planes of cleavage frequently at right angles to the plane of stratification, and generally inclining towards the northeast, at an angle varying from the horizontal to 45 deg.

Micaceous (gneiss) Hornblende, Quartzose, and Feldspathic Schists.—These schists are composed chiefly of quartz, feldspar, hornblende, and mica, in various proportions, and arranged in laminæ. In some cases, one of these minerals forms the principal constituent of a stratum, or a series of strata; again, a stratum will be composed of two or more, in equal, or different proportions.

In addition to the above, the following may be mentioned as constituents of the rocks in particular districts and localities, viz: magnetic iron ore (magnetite), iron pyrites, phosphate of lime (apatite), epidote, graphite (plumbago), garnet, chlorite, and talc.

Magnetite is a very general constituent of these rock. In particular belts or localities, it occurs almost, or quite pure, in distinct strata, varying from an inch to forty feet in thickness. (For localities, etc., see local details of mines.)

White Crystalline Limestone.—This metamorphic rock is most extensively developed in the Vernon and Wallkill valleys, where it occurs in an almost uninterrupted belt, composed of a series of ridges, extending from the State line nearly to the headwaters of the Wallkill river. It is traversed by numerous dikes of granite and syenite, some of which may be traced, with

White Crystalline Limestone Bluff, near Franklin Furnace, Sussex Co.

Mine Hill, Franklin Furnace

but little interruption, for a distance of two miles. It is noted for its great variety of rare minerals, its deposits of red oxide of zinc, franklinite, limonite, and specular iron. In Byram Township it occurs in irregular masses, or isolated hills, apparently without any connection with each other. Near the line, between the townships of Sparta and Byram, it forms the broken ridge of two irregular hills, about one half a mile northwest of the origin of Wallkill river. Here it occupies a space of about one half a mile in length, and from one hundred to two hundred yards in width. There are other localities in Byram Township where this rock occurs, viz: about midway between Lockwood and Whitehall, upon the turnpike, where it covers, at the surface, an area of about three quarters of an acre. Again, on the east bank of the Cranberry Reservoir, upon the line of the Sussex Railroad, where it extends in a northeast and southwest direction, about one hundred and twenty-five yards, and from fifteen to twenty yards in width. Again, about three hundred yards west of Wright's Pond, it occupies, in a northerly course, a length of about one hundred yards. Also, near the dwelling of Mr. Samuel Smith, about one half a mile south of Stagg Pond, it covers an area of between three and four square rods. And, lastly, upon the land of Mr. Anthony Hemenover, and others, it extends in a northerly and southerly direction, a distance of five hundred and fifty yards, with a width of from eighty to one hundred feet.

LOCAL DETAILS.

Northwestern Boundary of the Azoic Rocks of the Highlands, from the New York State Line to Vienna, Warren County.

From the State line to Robert Owens' Island, a distance of two thirds of a mile, the azoic rocks of the northwestern base of Pochuck mountain, are bounded by the alluvial deposit of peat and muck of the Drowned Lands, which are here about one mile in width, between the exposed rocks and the Wallkill river.

Near the residence of Mr. Owen, and along the road leading

from Wallkill river, over Pochuck mountain, to North Vernon, these rocks take a wider range, and are exposed from the road, in a northwesterly direction, towards Owens' Island, the south-eastern side of which is formed by a highly feldspathic syenitic gneiss, which is bounded by the limestone occupying the other portion of the island. The gneiss dips at an angle of 70 deg. to the southeast, its strike being N. 45 deg. E., by S. 45 deg. W. It contains numerous joints, having a direction S. 45 deg. E., and dipping at an angle of 80 deg. to the S. W. It is composed of feldspar, quartz, and hornblende. The feldspar is of a white color, sub-crystalline structure, and predominates over the other constituents. The quartz is of a dull grey color, and occurs chiefly in coarse grains, arranged in laminæ. The hornblende, which enters but very slightly into its composition, is of a pale green color, and is easily decomposed by the atmosphere.

The limestone rests uncomformably upon the gneiss, dipping at an angle of from 20 deg. to 25 deg. to the northwest. On crossing the island from the southeastern towards the northwestern side, the following varieties were observed:

1st. Gneiss of the above description, twenty feet in width.

2d. Limestone of a dirty blue color, and crystalline structure, thirty feet in thickness.

3d. Limestone of a dark blue color, containing more silica than the preceding; one hundred and twenty feet thick.

4th. Limestone of light blue color, containing a considerable quantity of silica in the form of small grains; sixty-five feet thick.

5th. Limestone of a bluish grey color, and of a compact structure, containing numerous seams of quartz, the direction of which is N. 45 deg. W. by S. 45 deg. E., dipping perpendicularly; one hundred and twenty feet thick.

6th. Limestone of a dark blue color, granular structure, highly silicious; (silica being finely disseminated through it in the form of small grains) and containing calcite in small white crystalline grains; one hundred and fifty feet thick.

From the southeastern side of Owen's Island, the exposed gneiss recedes to the road, leading along the northwestern base of Pochuck mountain, this road forming the boundary line between it and the overlying deposit of peat and muck. From the residence of Mr. Owen, in a southwesterly direction, for a distance of about one mile, the southeastern part of the alluvial deposits, from 200 to 500 yards in width, rests apparently, immediately upon the gneiss, while the portion near Mr. Owen's, between the Wallkill river and the mountain rests upon the blue limestone. On the turnpike leading across the Drowned Lands to Deckertown, blue limestone is again exposed, forming what is called Big, or Chandler's Island. It extends from the southeastern side of the island, where it disappears beneath deposits of muck and peat, in a northwesterly direction to the Wallkill river, and forms the steep and rugged banks of this stream, which vary from 15 to 35 feet in height. The strata dip at an angle of from 50 deg. to 65 deg. to the N. W.

On crossing Chandler's Island, from the southeast towards the northwest, several belts of limestone may be observed, which differ widely from each other, with respect to mineralogical and chemical composition. Across the Drowned Lands, towards Deckertown, the limestone is well exposed for examination on the northwest side of the turnpike, about two hundred and fifty yards N. 60 deg. E. of the house of Mr. Adam Quince. Its strike is N. 35 deg. E. by S. 35 W., dipping 68 deg. to the N. W. It is highly silicious, and contains, apparently, but little carbonate of magnesia. In it is occasionally found calcite of a yellowish white color, together with oolitic grains in irregular masses, some of which are one and a half inches in length, and one and a quarter inches in width. A series of narrow seams of quartz, from the thickness of a sheet of paper, to an eighth of an inch, traverse it in the following directions: N. 70 deg. W. by S. 70 deg. E.; N. 35 deg. E. by S. 35 deg. W., (coinciding with the strike of the strata); N. 45 deg. W. by S. 45 deg. E., (nearly at right angles to the line of strike.)

From the residence of Mr. Robert Owen, in a southwesterly direction, for a distance of nearly two miles, the road leading along the northwestern base of Pochuck mountain, forms the exact boundary line between the gneiss and granitic rocks, and the overlying alluvial deposits of the Drowned Lands. In several localities along this distance, granite and syenite form the very base of the northwestern slope of the mountain. The occurrence of granitic and syenitic rocks, forming the northwestern slope and base of this mountain, forms a striking contrast with its southeastern slope, where finely stratified gneiss almost universally prevails.

About two hundred yards north of the house of Mr. E. Martin, there occurs a granite composed of feldspar, quartz, and scales of both black and white mica. The feldspar, originally of a yellowish white and dull color, has decomposed into brown and flesh colors. The quartz is of a grey and dull color. It is traversed by numerous irregular joints, the more regular of which run N. by S.; N. 10 deg. W. by S. 10 deg. E.; N. 15 W. by S. 15 deg. E.; N. 20 deg. E. by S. 20 deg. W.; the system of joints in the last direction being the most regular.

About one and a half miles below Independence Corner, a short distance southwest of the road leading to Deckertown, blue limestone is again exposed, dipping at an angle of 40 deg. N. W., and resting upon the feldspathic gneiss of the lower part of the northwest slope of the mountain. From this point, in a southerly direction, for a distance of about one mile, the line between the gneiss and limestone is a little to the southeast from the road, between which and the Wallkill river, are numerous ridges and rounded hills of limestone. Thence turning to the east, until it is at a distance of about half a mile southeast of the Wallkill river, it follows in nearly a westerly direction, crossing the turnpike between Hamburg and Deckertown, at a point about three hundred and fifty yards southeast of the Wallkill river, and terminating at the southwestern extremity of Pochuck mountain, near the residence of Mr. Thomas Lawrence.

Following the boundary line from the termination of the mountain, the gneiss disappears, being overlaid by the limestone and drift, which form a series of hills, extending towards the southwest for a distance of more than two miles, with two exceptions, where it appears in the form of small knobs; one occurring about three-fourths of a mile from North Church (Hardiston village), near the road from that place to Hamburg, and the other, about three-fourths of a mile northwest of Franklin Furnace, at the side of the road leading from that place to North Church. It reappears a few hundred yards southwest of this locality, rising from beds of alluvion, which rest upon limestone and drift. In this vicinity its prevailing strike is N. 35 deg. E. by S. 35 deg. W., dipping in a southeasterly direction, at an angle varying from 65 deg. to 70 deg. This forms the northwestern termination of the Pimple Hill range. From this place it continues to approach, in its southwestern course, nearer to the road leading from North Church to Monroe Corner, being, at the line between Hardiston and Sparta Townships, at a distance of about a quarter of a mile southeast of Monroe Corner. The gneiss along this distance has the usual composition—feldspar, quartz, and mica.

The blue limestone resting on the northwestern slope of the hills of this range, with a strike of about N. 50 deg. E., and a dip of from 40 deg. to 50 deg. to the northwest, and unconformably upon the strata of gneiss, contains numerous small grains of quartz; and at many localities it partakes of a slaty character. From a point a little northeast of the Sparta and Hardiston line, in a southwesterly direction, deposits of drift intervene between the exposed gneiss and limestone; these, near Monroe Corner, are about two hundred yards in width, growing wider towards the southwest. Part of the drift rests upon limestone, and part immediately upon the gneiss.

From the Sparta and Hardiston line, the gneiss, for a distance of little more than a mile, continues in a southwesterly direction

[illegible] Smith, [illegible] the way of [illegible] of [illegible] and conglom- [illegible] the grist-mill, a silicious lime- [illegible] seen resting unconformably upon [illegible] limestone dipping to the northwest. The [illegible] southeast. About fifty yards west [illegible] and limestone, and northeast of [illegible] ferruginous conglomerate is exposed. The [illegible] cannot be ascertained on account of the [illegible] the grist-mill, the boundary of the [illegible] about two hundred yards, coincides with [illegible] of Smith's Pond. It then recedes from [illegible] its southwesterly course, and passing about [illegible] southeast of Kimball's Pond. Thence in [illegible] same direction, at a distance varying from three [illegible] one-third of a mile northwest of the road lead- [illegible] Corner to Putney's Corner, and crossing the [illegible] three-quarters of a mile from Kimball's Pond [illegible] along with [illegible] one mile and a half. [illegible] whole distance [illegible] alluvial deposits [illegible] exposed, it has a [illegible]

[illegible] three quarters [illegible] of white [illegible] in width, [illegible] It is generally [illegible] are, on account [illegible] may [illegible] [illegible]

on the road leading from Pinkney's corner to Monroe Corner. This dike is composed of feldspar, quartz, and grains of magnetic iron ore. The feldspar is of a yellowish white color, and generally of a highly crystalline structure. The quartz is of a light grey color; not unfrequently these two minerals form large masses by themselves. The occurrence of grains of magnetic iron ore in this dike, is an exception to the usual composition, as most of those penetrating the limestone of Sussex County, contain none at all. Near the house of Mr. Joseph Current, and not far from the bend of the road, the northeastern continuation of the eastern dike caps the limestone, an occurrence which has been repeatedly observed within the belt of metamorphic limestone of the Vernon valley.

About two miles below Pinkney's Corner, where a branch road runs to the northeast, continuing thence, in a nearly southwesterly direction, for a distance of more than one mile, strata of blue limestone, much water-worn, are exposed, resting upon syenitic gneiss. Approaching the Andover Mine, the gneiss is bounded by the drift which forms the level lands in which Long Pond is situated. It is composed of both white and flesh-colored feldspar, light green hornblende, light smoky quartz, and yellowish and green epidote, which enters quite largely into its composition. The strike of the strata is from N. 20 deg. E. to N. 30 deg. E., dipping at an angle of from 60 deg. to 70 deg. to the southeast. From the low hills, at the south-southwest termination of the ridge, in a south, and southwest direction, the exposed gneiss recedes a considerable distance to the eastward of the road between the mine and Andover. Near the grist-mill at the latter place, sandstone and conglomerate of recent origin occur to some extent. About one hundred and fifty yards from this grist-mill, it may be examined in a hill which rises from thirty to sixty feet above the level of the meadows. It varies much in its composition, some parts being chiefly of quartz grains, while others are an admixture of almost every kind of rock occurring in Sussex

County, among which may be mentioned blue limestone, and dolomite of various shades and differing in structure; pebbles of white metamorphic limestone; slate, and calcareous sandstone, (similar in character to those occurring in Wantage Township;) different kinds of gneiss, syenite, and granite, varying in size from small grains to six inches in diameter, cemented together by carbonate of lime. On account of its rapid decomposition, it is difficult to ascertain its exact dip, which appears to be towards the west at a low angle.

Near Andover, limestone is not exposed in immediate contact with gneiss, deposits of drift intervening. On the line of the Sussex Railroad, near its junction with the branch road to Andover Mine, a series of limestone strata occur, varying in composition, structure, color, and general appearance. A section made at this place shows no less than fourteen different varieties within a distance of two hundred feet. Their strike is N. 20 deg. E. by S. 20 deg. W.; their dip 79 deg. N. 20 deg. W. They vary in thickness from one to four feet, interstratified with strata of shaly limestone, from a half to several inches in thickness. They have, generally, a compact, granular structure; very small grains of quartz enter more or less into the composition of some of them, rendering them somewhat soft and gritty. Some layers appear to be composed almost entirely of carbonate of lime, while others seem to contain carbonate of magnesia, in variable proportions.

From Andover in a southwesterly direction, the boundary line between the gneiss and limestone, cannot, for some distance, be distinctly defined, on account of the drift by which it is overlaid. Its general course is northeast and southwest. Further to the southwest, it corresponds in direction with the road leading from Andover towards Alamuche, Warren County. It is probable that blue limestone rests immediately upon the gneiss, but being partly overlaid by drift, this cannot be well ascertained. About three quarters of a mile southwest of Andover, and one

fourth of a mile southwest of the dwelling of Samuel Wilgus, deceased, a limestone occurs, of a light blue color, quite hard, and of a slightly crystalline structure. Its strike is about N. 30 deg. E.; its dip at an angle of 50 deg. in a direction about N. 70 deg. W. It continues in the direction of its strike, and crossing the road from Whitehall to Huntsville, about three hundred yards east of Mr. James Vansyckle's house, it passes along the western side of the pond known as "Decker's Pond."

West of the above described limestone, occurs another, of a darker blue color, interspersed with shades of grey. It is quite hard; breaks with an exceedingly uneven fracture; is of a slightly crystalline texture, and contains calcite, which fills its joints. Its strike is N. 25 deg. E., and its dip 65 deg. in a direction N. 65 deg. W.; the direction of its cleavage is N. 5 deg. E. by S. 5 deg. W.

Limestone is also exposed at the upper end of Green Township, about midway between the dwelling of Mr. John Vansyckle and Decker's Pond, where it is of a greyish blue color, of a compact and crystalline texture, breaking with a very uneven fracture, and apparently containing much silica. Its width is from fifteen to twenty feet. It dips at an angle of 60 deg. S. W., and its strike is about N. 45 deg. E.

Next to it, occur a few layers of calcareous sandstone, of bluish and brownish colors, of a granular texture, quite hard, and breaking with both a slightly conchoidal, and uneven fracture. It consists chiefly of rounded and water-worn grains, of variously shaded grey colored quartz, cemented by carbonate of lime.

On the southeastern side of Decker's Pond, occurs a series of limestones, having a strike N. 40 deg. E., and a dip at an angle of 45 deg. to the N. W. They are characterized by their hardness and compactness of structure; the varieties differing chiefly in the proportion of silica in them. One or two, however, are somewhat porous, and contain considerable calcite; another variety contains scales of mica. Forming a portion of this series,

are a few laminæ of a calcareous slate. Between these and the gneiss, occurs a bluish-grey limestone, with grains of quartz disseminated through it. It is but a few feet in thickness. Next to this, and bounding the gneiss, is metamorphic limestone, traversed by two or three dikes, the principal of which is a coarse aggregate of crystalline feldspar and rounded grains of quartz. This limestone is about one hundred yards in width, and its outcrop nearly half a mile in length. It differs much at various places, in regard to color, texture, quality, etc., being in some places white, and apparently free from all foreign substances; while in others, it contains many impurities, such as large grains of quartz of a dark grey color, mica in scales, chlorite, hornblende, plumbago, etc. There are portions which are but partially altered; the stone, in part, retaining its original color, but generally containing impurities. Other portions, still, are of a blue color, containing here and there a little calcite, in which there is considerable plumbago. In the parts which are but slightly altered, the texture ranges from compact to subcrystalline; and in those which are more completely changed, from subcrystalline to that which is highly crystalline: thus passing by regular gradations from ordinary blue limestone to that which is highly metamorphic.

The gneiss, near Decker's Pond, extends from twenty-five to one hundred yards northeast of the road from Andover to Tranquility, crossing it about half a mile below the pond.

The road, in its continuation to the county line between Sussex and Warren, and thence, through the village of Alamuche to Long Bridge, coincides very nearly with the boundary of gneiss. From this point to the county line, limestone, dipping to the N. W., rests upon the gneiss, although it is not exposed directly in contact with it, on account of an intervening belt of drift, which, in turn, is bounded by extensive alluvial deposits. Upon the drift alluded to, as well as upon the northwestern slope of the Alamuche mountains, are numerous large boulders of blue limestone.

From Long Bridge, it continues to a point opposite Vienna, the drift bounding nearly the whole of this distance. Where it does not bound it, the alluvial deposits, along the Pequest river, lie next to it. Within the limits above mentioned, the gneiss preserves its steep southeastern dip, with but one exception, viz., at a quarry owned by Nelson Cummings, at the road side, three miles and a half below Alamuche, where it dips to the N. W. at an angle of ten deg. At this locality, it is more or less coarsely granular, and is composed of quartz of a light grey and smoky color, with a vitreous lustre; feldspar of flesh, red and brown colors, and particles of magnetic iron ore arranged in layers. This is the first instance along this line where the gneiss has been observed to dip to the northwest. There are two systems of joints occurring in the gneiss of this locality—one extending in a direction N. 20 deg. E., by S. 25 deg. W., dipping at an angle of 80 deg., in a direction S. 30 deg. E., and the other at right angles to the first.

Southern Boundary of the Highlands, from the New York State Line to Morristown, Morris County.

From the State line, nearly to Pompton, a distance of about ten miles, the Ramapo river runs close to the southeastern boundary of the azoic rocks. Along this whole distance they are bounded by drift, and are in close proximity to large dikes of trap (melaphyre), some of which are within a few hundred yards of them.

About one mile northeast of the church at Pompten, the strata of gneiss occupy a vertical position; a short distance from which they are seen dipping to the northwest, at an angle of 80 deg., while, but a few yards to the southeast, they dip at the same angle in the opposite direction. The joints traversing them are at right angles to the line of strike. The rock, at this locality, is varied much by the proportion of its constituents; being, in some places, composed of yellowish-white feldspar, light colored

quartz, mica, and hornblende of a pale green color; in others, of feldspar and hornblende; and in others, again, of a finely granular admixture of quartz and feldspar.

The drift resting upon and bounding the gneiss along the course of the Ramapo river, forms a series of low hills, the more regular of which take a northerly and southerly direction. The boulders in the drift are of gneiss, granite, syenite, conglomerate and sandstone from the Green Pond Mountain, red sandstone, brownish, bluish and argillaceous sandstones, etc. As a general thing they are distributed very unevenly through the sand and gravel. There are, however, a few localities where there is a regular arrangement of the sand, gravel, pebbles, etc. About three-eighths of a mile N. 20 deg. E. of the Pompton Church, may be seen thin layers, composed of these materials, some of which dip to the south and some to the southeast, at low, but variable angles.

Near Pompton, the boundary line takes a turn northwest by west, passing above the church; and seven eighths of a mile west of the same it again bends, pursuing a southwesterly course. Resting upon this limit of the rock, is drift, of about the same character as that already described.

Two and a half miles from the last mentioned turn in the boundary line, and two and a quarter miles west of the Pequannock river, occurs, bounding the gneiss, a conglomerate, of alternating layers, of a coarsely and finely granular structure, dipping, at a slight angle, to the northwest. The lowest layers exposed, are composed of grains and small pebbles of quartz, of a dull grey color; soft, decomposed sandstone; compact feldspar; numerous scales of copper, and silver colored mica; scales of plumbago, etc. The grains of quartz and feldspar predominate, and are, for the most part, rough and angular. The upper layers, possessing a coarser structure, are composed of granite, gneiss, etc., rounded and smooth. The cementing material of both these varieties is the oxide of iron, to which their color, a reddish brown, is due.

From this locality, the gneiss continues in a southwesterly direction, keeping from one-eighth to three-eighths of a mile northwest of the road leading from Jacksonville to Beaver Dam Creek, the drift still bounding it for a distance of about two and a half miles southwest of the conglomerate above mentioned. At this place the gneiss comes in contact with trap (melaphyre), which continues with the line of the gneiss for a distance of about three hundred yards; this melaphyre is composed of labrador-feldspar and pyroxene; it is exceedingly hard, having a structure from finely granular to massive. It contains geodes of quartz, zeolites, etc.

The line of the gneiss continues on to the southwest, bounded by the drift, except at one locality, about three-eighths of a mile from the trap just spoken of, where cong lomerate very similar to that already described, but of a little lighter color, occurs. From this locality, the line of the gneiss and syenite turns westward, and, as usual, is bounded by drift.

One mile northeast of Montville, a syenite occurs, composed of grey colored quartz, intimately mixed with compact feldspar of a pink color, and small particles of hornblende rapidly decomposing. In this rock, the quartz is the most abundant constituent; many irregular seams, of an admixture of feldspar and hornblende, run through it; and it is also traversed by numerous but irregular joints.

At Montville, at the roadside, near the inclined plane on the Morris Canal, again occurs a conglomerate, consisting of alternate coarse and fine layers, dipping at an angle of 10 deg. to the northwest. It is composed chiefly of quartz, flesh colored compact feldspar possessing a vitreous lustre, granulite of a rather fine texture, granite, gneiss, syenite, dark grey quartz, trap (melaphyre,) etc. These grains and pebbles vary in size, from that of a pin-head to more than an inch in diameter; they are cemented, as in the former case, by oxide of iron.

From Montville, the line between the exposed gneiss and drift

continues in a southwesterly direction, passing through Boonton, bounded the whole distance by the drift, the boulders of which show no regularity in their arrangement. From thence it continues nearly parallel with the line between the townships of Rockaway and Hanover, at a distance of from one to one and a half miles southeast of that line. The gneiss here is remarkable for rapid decomposition and disintegration.

At the line between the townships of Morris and Hanover, it bends towards the west; afterwards it takes a course nearly south, which it pursues for some distance, and then deflects to the east towards Morristown.

Enumeration and Local Details of Mines.

Observing the same order of arrangement in the enumeration of the mines and metalliferous deposits of this division, as was followed in enumerating the mountains and valleys, we begin with the most northwesterly metalliferous belt of the Highlands, which includes Pochuck, Pimple Hill, Andover, and Alamuche mountains, with the Vernon and Wallkill valleys.

In the Pochuck mountain, no metalliferous deposits, that are at the present time considered of economic value, have been found. The occurrence in the rocks of magnetic iron ore, and iron pyrites, in the form of grains disseminated through particular strata and in seams, bands, and bunches of very limited extent, have occasioned numerous openings in search of ore.

The Copperas Works, in Vernon Township, near Decker's Pond, is one of these. Here, iron pyrites constitutes the greater portion of a stratum of rock, which was worked some forty years ago to a considerable extent, for the purpose of manufacturing copperas from the ore.

The Pochuck mine, another, is situated about two and a half miles northeast of Hamburgh, and three quarters of a mile southwest of Smithville, immediately upon the line of the gneiss of the Pochuck mountain, and the white metamorphic limestone. This

mine was worked many years ago; and the ore was smelted at the Hamburgh Furnace. It is now owned by Col. Joseph Edsall. The ore is limonite (brown hematite), and occurs in the form of a very irregular deposit, which apparently is almost exhausted.

THE SIMPSON MINE—still another, is situated about half a mile southeast of the dwelling of Mr. Robert Simpson, near Smithville. It was opened several years ago, and about eighty tons of ore taken out and smelted at the Hamburgh Furnace. The ore is specular, and occurs in a small deposit in the metamorphic limestone.

Between the Pochuck and Simpson mines and Hamburgh, boulders of limonite and specular ore are quite abundant.

From Hamburgh, in a southwesterly direction, no deposits of ore are met with, until near Franklin Furnace, where there are extensive deposits of Franklinite and magnetic iron ore, with more or less red oxide of zinc, in connection with the former; all of which have been worked.

About two miles southwest of Franklin Furnace, at Sterling Hill, there are two deposits of franklinite and red oxide of zinc, in the metamorphic limestone, near its junction with the gneiss of the Pimple Hill range.*

Following this range in a southwesterly direction, no deposits are met with until within one mile and a half of Andover, Newton Township, where the Tar mine is situated, and three-quarters of a mile further to the southwest, the Andover mine.

These mines are situated in a metalliferous ridge, which runs parallel to, and borders Long Pond. It is from one-eighth to one-fourth of a mile wide, and rises to the height of from one hundred and fifty to two hundred feet above the level of the water in the pond. The prevailing rock of this ridge is a dis-

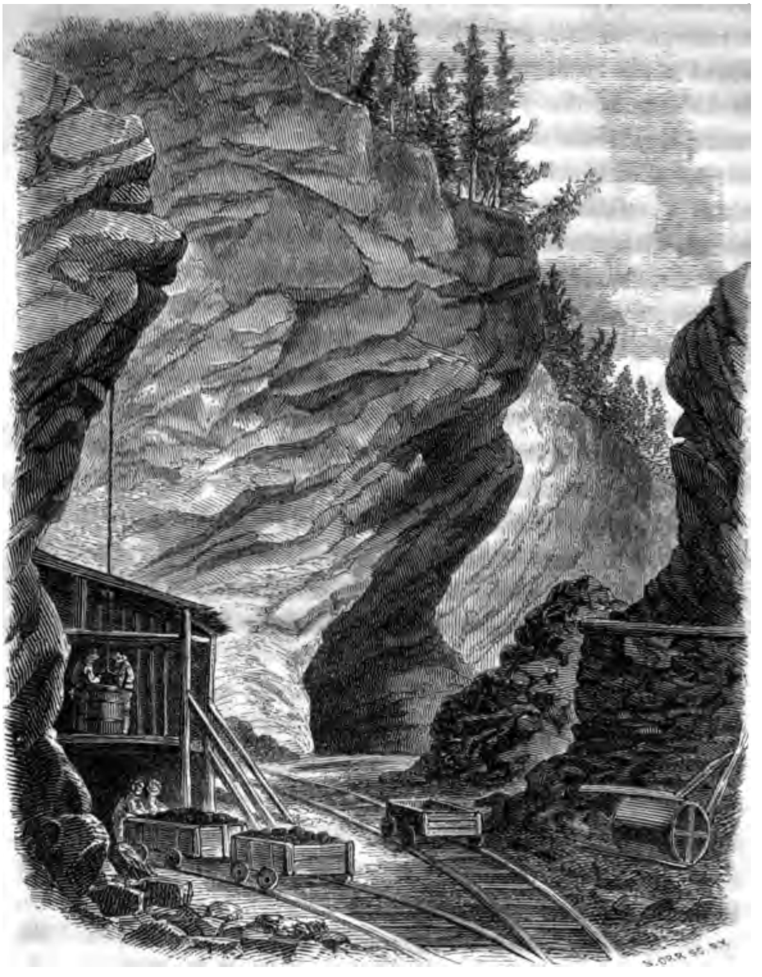
* The above mines will be minutely described in the final report on the county of Sussex, now in course of preparation.

tinctly stratified gneiss, dipping at an angle of 70 deg. to 80 deg. to the southeast, and composed of feldspar, hornblende, mica, quartz, and frequently in admixture yellowish green epidote, red garnet, magnetite and iron pyrites, in crystals, grains and masses. The ore-bearing rock of this ridge is from twenty to one hundred feet wide, and for the most part consists of massive red garnet, iron pyrites, magnetite, epidote, calcite, dark green hornblende, feldspar and quartz. The garnet and iron pyrites predominate over the other constituents.

Tar Mine.—At this mine two large openings have been made; one about sixty feet long and seventy feet wide, and the other about one hundred feet long and ten feet wide. At the time of their examination they were both filled with water, which necessarily confined the examination of the mine to the surface, and to the rock which had been thrown out. The ore is chiefly an admixture of magnetite and iron pyrites, the latter constituting by far the greater part. Mr. Wurtz has mentioned the following minerals as occurring here. "Some specimens were selected from the rubbish lying around each of these openings, which comprise magnetite having regular cleavages, sometimes in regular octahedrons, generally associated with pyrites; green epidote in crystals, with calcite, having curved cleavages, in garnet rock, containing incrustations of calcite in fissures; and some others of less importance.

"Proceeding probably half a mile farther in a N. E. direction along the summit of the ridge, we come to Longcore's mine, where there are two more small abandoned openings on a seam of ore a few feet wide. The openings were both partially full of water, but it could not be seen that the seam of ore was highly pyritous. The northeasterly opening is upon a higher level than the other, and probably fifty yards distant from it. A considerable number of miscellaneous specimens were picked up at both openings, including the following:

"(1.) From the S. W. opening, pyrrhotine, mixed with



ANDOVER IRON MINE SUSSEX CO

pyrites; crystallized green epidote, with red garnet, pyrites, etc.; a transparent dark green feldspar, similar in appearance to that found at the Hurdtown apatite locality; seams and bunches of hornblende of the coccolite variety in red garnet; a greenish black hornblende in distinct prisms, several inches long. The pyrites of this mine, which occurs in large masses, and is sometimes crystallized in regular cubes, contains neither copper, nickel, manganese, nor zinc.

"(2.) From the N. E. opening, magnetic iron ore, possessing perfect crystalline cleavages, and polaric, mixed with much pyrites; a feldspar rock containing much greenish white and yellow epidote; a granular garnet rock, containing seams of white and green feldspar, yellow epidote, and quartz; mixtures of black hornblende, white and green feldspar, etc."

Andover Mine.—Mr. Wurtz has described this mine, together with the minerals occurring in its vicinity, as follows: "The ore-bed here is imbedded in the same kind of rock as the ordinary magnetic iron ore seams of this region, and bears a general resemblance to them also in configuration and structure, the longer axis of the mass of ore lying in a direction from N. E. to S. W., or parallel to the strata of the gneiss rocks of this country, and the walls of the ore-bed, wherever they are well defined, being vertical, or nearly so; but the ore itself is, for the most part, quite different in its nature, approaching generally more nearly to the constitution of hematite, or red oxide of iron, a substance which differs from magnetite or the black oxide, only in containing more oxygen. These ores generally contain, moreover, a much greater proportion of manganese and zinc than the magnetic ores, and usually quantities of these metals which must exert an important influence upon the quality of the iron made from it. There are also associated with this ore bed, in various places, quantities more or less great of minerals containing lead, copper, zinc and manganese, which are not found at the other mines; so that this mine, while it may be considered as belonging to the same *family* of mineral formations as the magnetic ore seams

which have been described, must be admitted to be of a different *species*.

"In addition to the facts given with regard to this mine, in the Report of the Survey of 1854, page 39, I am enabled to give the following additional information, acknowledging first my indebtedness for the numbers and measurements given, to Mr. Richard George, the Superintendent of the mine.

"The open excavation, which has been made along the course of the ore deposit, from N. E. to S. W., is seven hundred and fifty feet in length, and from thirty to sixty feet or more in width, and very variable in depth. At the S. W. end, the depth of the deposit appears usually to have been small, although in places it increases to perhaps thirty or forty feet, forming what may be called basins or bowls, formerly filled with ore. There are two or three of these basins, in the southwestern portion of the mine, the ore of which has been entirely worked out. Proceeding towards the N. W., we find another basin of very great size, several hundred feet in length, and eighty-five feet in depth, where the deposit expands to an average width of sixty-five feet, its maximum width being as much as seventy-five feet. In this part of the mine also the ore has been mostly worked out, leaving a vast pit, the side walls of which are generally vertical, and the bottom very uneven and irregular. To convey any distinct idea of this excavation by words, without the assistance of drawings, would be impossible, so that I shall confine myself at present to a few special observations.

"In the bottom of this excavation there are two principal bowl-shaped cavities, with a ridge of rock rising between them, the longitudinal direction of which is the same as that of the whole mine. The cavity on the S. E. side of this ridge is much the deepest, and the S. E. wall of the ore-bed, or the hanging wall, as it is called, and as it actually becomes, farther to the N. E., in what is called the middle slopes, where the ore-bed assumes a steep dip to the S. E., presents the appearance of a perpen-

dicular precipice, eighty-five feet high at the highest place, and two or three hundred feet in length. Upon the wall is perceived an appearance similar to that described as occurring upon the foot wall at the entrance to the Mount Hope Open Workings, namely, a marking or furrowing of the face of the rock, the furrows being, however, in this case, unlike those at Mount Hope, very irregular and ill-defined. These furrows, like those at Mount Hope, dip towards the N. E., though at a somewhat greater angle, which in this case may amount, according to my best recollection, no measurement having been made, to about 15 deg. from the horizontal. The degree of this inclination may be of importance to the comprehension of the form of those parts of the ore bed, which have not yet been opened, lying to the N. E., where the upper boundary or limit of the ore bed sinks below the surface of the rock. Some of the furrows visible on the hanging wall, are filled with a pulverulent hydrated sesquioxide of manganese.

"The immense mass of ore which has been taken out of the great basin above described, had a peculiar structure. There are two principal varieties of ores found, known to the miners by the names of "blue ore" and "red ore," of which full descriptions will be given hereafter. The mass of the ore-bed presents the general structure of a kernel of the blue ore, surrounded by a thick shell of the red ore. Thus, on the top, the ore is found to be of the red variety, and the same next to the two walls, and the bottom of the deposit, while the centre is usually of the blue variety.

"Passing on to the N. E., from the great basin, we come to the middle stopes, where the miners were at work at the time of my visit. It is about here that the railroad upon which ore is taken to the Morris canal at Waterloo, seven miles distant, enters the mine. Upon this railroad there were being run, at the time of my visit, five ore-trains per day, carrying each fifty tons of ore. The workings at the middle stopes have reached to some twenty-

five or thirty feet below the level of the railroad, and at this point the ore bed is much narrower than usual. Passing onward to the N. E., the workings are no longer open to the sky, but are entered by means of drifts and shafts. They extend about two hundred feet beyond the middle stopes, making the whole distance throughout which this ore deposit has been opened, nearly one thousand feet. In the extreme N. E. workings, the width of the ore averages about thirty feet, and the lowest point, or deepest part of the whole mine, is fifty feet below the railroad. The ore in the N. E. stopes approaches more to the condition of magnetite, being in some places identical in appearance with some of the ores of the ordinary magnetic iron seams in Morris County, as will be seen from the descriptions of the specimens given below.

"Some superficial excavations have been made to the N. E. of the mine, and lead and copper minerals found. In one place has been thrown out a considerable quantity of galena, and at another some materials containing malachite and copper pyrites, but from the indications observed, there is small reason for expecting to find these minerals in regular veins, or in any form sufficiently reliable to justify mining operations.

"Some two hundred yards or more to the N. E., nearly or quite in a line with the great ore bed, appears another opening, made into a seam of ore of some size, which crops out on the steep slope of a hill. The materials thrown out appear to be principally mixtures of magnetite with a great deal of pyrites. Near the surface considerable galena appears in bunches. Specimens were collected at this spot.

"Proceeding on farther in the same direction, many more superficial indications appear of the presence of different varieties of iron ores, the whole vicinity appearing to be highly metalliferous, and to merit a much more thorough exploration.

"Mr. George states that during the time that he has been in superintendence of the mine, now about eight years, more than

120,000 tons of ore have been sent away, and at the time of my visit, there were about 3,500 tons lying at the mine awaiting removal. There were seventy men employed at the mine during the last summer; the greatest number ever employed at any one time being ninety-eight, in the month of November, 1854. The ore all goes to the furnaces of the Trenton Iron Company (who are the proprietors of the mine), near Easton, and is there used, in combination with other ores, in the making of the pig iron, which is now being puddled and manufactured into wrought iron beams for buildings, at the works of the Company at Trenton. In this connection, I may state that at my request, Mr. Charles Hewitt, the Superintendent of the Iron Works referred to, has had the kindness to procure for me authentic suites of specimens, illustrating every step in the processes of the manufacture of iron from the ore of the Andover mine, a portion of the ore having been taken specially for the purpose, and followed through the whole operation, reserving samples of the results of each step.

"The specimens are as follows:

1. Andover ore.
2. The limestone used as flux.
3. The pig iron, made at Easton.
4. The slag from the blast furnace.
5. The puddled iron, made at Trenton.
6. The puddling furnace cinder.
7. The reheated iron.
8. The heating furnace cinder.
9. The finished iron.

"They are all of large size, and besides being ornaments to the State Cabinet, and in the highest degree valuable and instructive, as illustrating in the most palpable and practical manner, the subject of the iron manufacture, they will furnish me an important opportunity to investigate the process chemically, by making analyses of the various samples, a comparison of

which will throw new light upon the changes and reactions which take place, and furnish data upon which to base improvements. Thus Mr. Hewitt has placed the community, as well as myself, under obligation.

"A very large collection, comprising some hundreds of specimens, was made at Andover, in order to represent not only the kinds of ore from different parts of the mine and their associated rocks, but also the great variety of interesting minerals which are found in profusion in and about the mine. Some of the specimens collected are of large size, and several of them may be pronounced to be among the most remarkable and interesting of their kind. In describing the specimens I will commence with those from the most southwesterly portion of the excavation, and proceed towards the N. E., considering the miscellaneous specimens last.

"(1.) Ore from a basin or cavity, situated at the S. W. extremity of the mine, which is a mass of nodules of red and black hematite, of irregular forms and sizes, cemented together, and containing much crystalline yellow blende (sulphide of zinc.)

"(2.) Ore from another basin lying intermediate between the above and the great basin, and situated upon the highest part of the hill, which is composed of small, hard, compact granules of the black hematite, cemented by the red hematite, which is silicious and somewhat jaspery in appearance in some places. These two varieties of hematite, which make up the great mass of the ore throughout the greater part of the whole bed, require special description. The red mineral consists essentially of red oxide of iron, most usually, if not always, mixed in the most intimate manner possible with more or less silica, so that the mass possesses sometimes the fracture and lustre of quartz, although having also the red color of hematite; and sometimes the silica appears to be wholly or partially in the amorphous or opaline condition, and the mass has a jaspery fracture, forming, when

the color is bright, as it frequently is, very pretty specimens of red jasper. The black mineral, which forms the greater portion of the centre of the mass of the ore-bed, as before stated, and is called 'blue ore' by the miners, from a bluish tinge which it has, appears to differ from the red mineral principally in containing more or less manganese, in the form of sesquioxide or deutoxide, or both, and to this admixture its color is probably in some cases due; although, from the fact that it is usually attracted to some extent by the magnet, it may contain a small quantity of magnetite; but still it is difficult to imagine how magnetite can exist in the presence of any of the higher oxides of manganese, supposing this ore-bed to be of igneous formation, or to have ever been subjected to the action of a heat sufficient to fuse or semifuse its contents. Here then is a point, which when settled by the investigations which I now have in progress, must throw some light upon the nature of the agencies concerned in the formation of this mass of ore. It must be remembered that, according to the investigations of Delesse,* hematite ore is sometimes magnetic, its maximum attractibility being represented by the number 2.35, that of steel being 100, and that of magnetite ranging from 15 to 65. It is possible therefore that the magnetic force of the Andover mineral may be due to the sesquioxide of iron which it contains as its predominating ingredient, although in my opinion it is frequently too well marked to be attributed to anything but an admixture of magnetic oxide. There is a difficulty in determining the condition of oxidation of the iron in a mineral like this, which contains one of the higher oxides of manganese, as on solution in an acid the iron is inevitably sesquioxidized by the oxide of manganese. In view of the peculiar composition of this black mineral, I have been at a loss by what name to designate it, as it must be frequently spoken of in this report; but I have finally concluded to call it 'black hematite,' because it is essentially hematite, and derives its dark tinge

* See Dana's Mineralogy, 1854, I, 176.

merely from some admixture, whether this be magnetite or one of the oxides of manganese, or both. I must remark, however, that I do not intend to compare it with the doubtful species psilomelane, which, as I should have remarked before, it sometimes resembles very much in appearance, and to which the name 'black hematite' has also been applied.

"The so-called 'red ore' of the mine, is a mixture in very variable proportions of the black hematite with the red hematite, the latter usually predominating, and forming sometimes, apparently, the cementing material which binds together the nodules or granules of black hematite. All the ores of this mine are excessively hard, and strike fire with steel, owing to the silica which they contain.

"(3.) Specimens from the mass of ore formerly existing in the great basin.

"(*a.*) Two varieties of ore, which were found in the upper part of the bed near its surface, the first of which is composed of cemented nodules of black hematite, irregular in size and shape, and distinctly attractable by the magnet, containing also much calcite in small seams and disseminated; while the second is a pulverulent mixture of granules of the black hematite with amorphous red hematite.

"(*b.*) Ore from the southeast side of the bed next to the hanging wall, which is 'red ore,' or a mixture of the black and red hematites, the latter predominating, and possessing the jaspery or subvitreous fracture usual to it. It contains numerous seams of calcite.

"(*c.*) Rock from a 'horse,' or small seam, which pervaded the ore-bed not far from the hanging wall, and parallel to the latter, which is a schist composed principally of a dark colored mica, with fissures lined with incrustations of calcite, which are sometimes columnar in structure.

"(*d.*) 'Blue ore,' from the central portion of the bed, which is hard, heavy, black, and nearly or quite amorphous, with a

brilliant lustre on the surfaces of fracture, magnetic to an important degree, and even polaric. It is full of brown garnet and honey-yellow blende in particles, laminated in its structure, and penetrated in every direction by small seams of white calcite.

"(*e.*) Ore from the northwest side of the bed, next to the foot wall, which is precisely similar to (*b*) the ore from the southeast side.

"(*f.*) Ore from the same side as (*e*), but from the bottom of a basin which exists there, which is apparently identical with (*e*) and with (*b*.)

"(4.) Ore from the middle stopes, where the ore-bed descends under the rock. In this part of the mine, the red variety of the ore decreases and entirely disappears, the whole mass being of the blue kind. There were collected specimens of several different varieties of the blue ore, which differ principally in their structure and mode of aggregation, and not much in their composition; some being granular; and others compact, with a black, jasper-like fracture and lustre, and having a large jointed cleavage; together with all the gradations between these two extremes. All are more or less magnetic, but the attractibility is confined to particles diffused more or less abundantly throughout the mass, of which some specimens contain but few.

"(6.) Miscellaneous specimens.

"(*a.*) Garnets, with willemite, etc. This garnet occurs in crystals, probably as large as any found in the world; one which I have, although broken, retaining several of its faces in perfect condition, which show by their size that the whole crystal must have been at least six inches in diameter. Others are very plentiful, from the diameter of half an inch up to two or even three inches. The smaller crystals sometimes retain considerable polish, but the larger ones are dull, apparently from the effect of alteration. They are rhombic dodecahedrons, and in some of the larger specimens, the edges are truncated. The color of this garnet is chocolate brown, and it is generally opaque,

and fragile from the effect of alteration. From the frequent association with it of willemite, or silicate of zinc, and of hydrated sesquioxide of manganese in fine powder, filling cavities, and from its apparently considerable weight, it is suspected to be highly manganiferous, or zinciferous, or both, and an analysis will be made to determine the point. The specimens of garnet collected, include masses a foot or more in diameter, covered with crystals of various sizes, and forming exceedingly fine specimens. The willemite, which occurs in hexagonal prisms, generally of a greyish color, but sometimes nearly white, among the garnet crystals, is a very rare mineral species, of which I can find but one known European locality, and but two others on this side of the Atlantic, both of which are in New Jersey, namely, Mine Hill and Stirling Hill, in Sussex.

"(*b.*) Calcite, or carbonate of lime, in a great variety of forms; such as seams of a white color pervading nearly all the other materials of the mine and masses of crystals, of white and beautiful salmon colors. Associated with masses of calcite of the latter color, were found irregularly, but very sharply angular, nodules of the bright red jasperoid hematite, imbedded in black hematite, presenting a very singular appearance. Sometimes calcite of a white color occurs together with the black and red hematites, in alternate narrow bands, presenting a striped, agate-like appearance, and these bands or laminæ will be crossed again at various angles by seams of white calcite or quartz. The crystals of calcite sometimes present the pearly lustre and curved surfaces of dolomite, but contain no magnesia. The surfaces of the crystals are sometimes striated parallel to the lateral axes of the rhombohedron. Masses and seams of calcite occur, having these curved and striated cleavages an inch or two across; such seams were found enclosed by surfaces of crystalline red hematite, having a mamillary aspect. Calcite also occurs in the form of a great variety of incrustations upon the ore and upon the rocks, showing every gradation of beauty and delicacy, some amorphous,

some mamillary, some botryoidal, some crystalline, and some in the form of dog-tooth spar, together with another very beautiful one, consisting of a congeries of very flat rhombohedrons, almost thin enough to be called plates. None of these various incrustatations contain any magnesia, but several of them contain much zinc, especially the one last spoken of, which probably owes its peculiar form to the presence of zinc. Indications were encountered which seem to prove that the process of formation of these incrustations is now, or has been at some recent period, going on, as heaps of fragments apparently of artificial formation, were found incrusted, and even cemented together.

"(*c.*) Blende or sulphide of zinc in crystals, sometimes black, and sometimes transparent and of a beautiful honey-yellow color, the former variety associated with malachite and drusy quartz, and the latter in masses of angular fragments of hematite cemented together by calcite.

"(*d.*) Fluor spar, of a dark violet color generally opaque and massive, but sometimes transparent and giving indications of an octahedral cleavage, imbedded in quartz and associated with calcite. Besides the mineralogical agreement of this mineral with fluor spar, chemical examination proved it to be that species, and deep etchings were produced on glass by its means. Before the blowpipe, previous to fusion, the mineral loses its violet color completely, becoming pure white and opaque.

"(*e.*) Galena or sulphide of lead is principally found at points N. E. of the large mine, and will be spoken of again below.

"(*f.*) Chalcopyrite or copper pyrites occurs in patches diffused through masses of calcite, which have large curved and striated cleavages.

"(*g.*) Malachite or green carbonate of copper generally amorphous, associated with amorphous hematite, and drusy quartz; sometimes also with a black pulverulent substance, which is cupriferous, and is either oxide or sulphide of copper, or a mixture of both; also occasional patches of azurite.

"(*h*.) Magnetite is found occasionally in regular octahedral crystals.

"(*i*.) Talc of a beautiful green color and very pure is found quite abundantly in many parts of the mine, sometimes in a white opaque calcite, and red jasper, making specimens of a striking aspect, from the contrast of color.

"(*k*.) Mica (phlogopite?) of a black color, and perfectly opaque, in plates sometimes an inch in diameter, in large masses of a singular appearance, the cleavages of the mica not lying parallel, but arranged in all planes, in a very disorderlym anner; sometimes mixed with an amber-colored garnet.

"Other miscellaneous specimens are various singular mixtures and conglomerates of the various minerals found in the mine; including masses of very irregular nodules of hematite, sometimes crystalline, sometimes amorphous and angular in shape, cemented together by calcite, and having thick incrustations of finely laminated hematite; the calcite is frequently interspersed with crystals of honey-yellow transparent blende. Some of the large angular nodules of hematite in these heterogeneous mixtures are themselves finely laminated, and evidently fragments of former incrustations, which have been broken into pieces by some convulsion, and afterwards re-cemented. These form very beautiful and useful specimens for illustration.

"Masses of hematite were found containing cavities lined with drusy quartz, and containing a mineral in small, long, flat, thin, transparent prisms, arranged in groups radiating from centres. These crystals were too small to be measured, but under the magnifier appeared to be of the monoclinic system, or possibly hemihedral forms of the trimetric system. Their chemical composition makes them a hydrated silicate of zinc, so that they are most probably calamine, which is trimetric. This mineral will be analyzed.

"(7.) Specimens from the shallow excavations N. E. of the great mine. These include masses of limonite, containing amor-

phous malachite and azurite; pulverulent limonite in very large masses; malachite incrustations on jasperoid hematite; massive pyrites, honey-combed by oxidation; a red rock, composed of an intimate mixture of finely granular hematite and calcite; various singular looking mixtures of calcite, hematite, and chalcopyrite, presenting a spotted leopard-skin-like appearance in fracture.

"Here, also, is found galena in some abundance. It is generally finely granular and incrusted, and mixed with a yellowish pulverulent substance, which is a carbonate, and therefore probably amorphous cerusite. It contains no appreciable quantity of silver.

"(8.) Specimens from the opening on the hill-side N. W. of the mine, mixtures of magnetite, cupriferous pyrites, and wine-red garnet in crystals, which form the mass of the seam of ore, sometimes in admixture with calcite, a little chalcopyrite and green hornblende. These minerals are mixed together in all proportions, and some specimens contain principally magnetite, to the exclusion of the others.

"The cupriferous pyrites above spoken of, which is found quite abundantly, is not chalcopyrite, as it is lighter in color, harder, (although not equal in this respect to common pyrites,) and contains much less copper. It tarnishes to bronze and irised tints. It much resembles in character the supposed peculiar cupriferous pyrites, observed at the Mount Hope Tunnel, associated with the supposed new titaniferous mineral found there. An analysis will be made to ascertain both its nature and whether it is worthy of exploitation, for the copper it contains.

"Other specimens found at this spot are terminated prismatic crystals of hornblende, the faces of which were, however, much altered and roughened, (I : I with the common goniometer=123½ deg.; hornblende is 124½ deg.) associated with apatite in green prisms, and crystallized calcite, in a granular crystalline garnet

rock; a very curious rock, composed of crystalline calcite, with numerous irregularly shaped granules of a dark green mineral, resembling serpentine, patches of chalcopyrite, and some green transparent crystals of apatite interspersed through it. The galena which occurs here, is in considerable quantity, presents cleavages of some size, and is imbedded in garnet rock.

"It will be interesting to give here in recapitulation, a list of all the minerals found at the Andover mine, and in the immediate vicinity, including three or four found at the Tar and Longcore mines.

"Garnet, crystals sometimes several inches in diameter, of chocolate-brown, amber-yellow, and wine-red colors.

Willemite, in hexagonal prisms, some nearly white in color.

Earthy manganese, (hydrated sesquioxide?)

Calcite, opaque, white and salmon-colored crystalline, striated, and with curved cleavage surfaces, also as dog tooth spar, and varieties of mammillary incrustations, also zinciferous calcite, in very much flattened rhombohedrons.

Blende, opaque, black, and transparent honey-yellow.

Fluor spar, of dark violet color.

Galena, cleavable, and granular.

Cerusite (?) amorphous.

Chalcopyrite.

Malachite, amorphous.

Azurite, in incrustations.

Quartz, drusy, and other forms, such as jasper.

Magnetite, massive and in regular octahedrons.

Talc, pure, and of green color.

Mica, black opaque.

Hematite, crystallized, and amorphous.

Calamine (?) in small transparent prisms.

Limonite, massive, and pulverulent.

Pyrites, in numerous forms.

Hornblende, in crystals; variety coccolite at Longcore's mine.

Apatite, in transparent green prisms.

Epidote, in green crystals, at Tar Hill mine, and elsewhere, and of yellow color at Longcore's mine.

Pyrrhotine, at Longcore's mine.

Feldspar, translucent green, at Longcore's mine."

CHAPIN MINE.—The next and last in this range, in Sussex County, is a mine in Green Township, near Decker's Pond, which was opened by Mr. Daniel Chapin, of Sparta, and afterwards owned and worked by the Glendon Iron Company. The deposit is of magnetic iron ore, and occurs at the junction of the metamorphic limestone and gneiss. The ore contains a large proportion of pyrites and hornblende.

Several openings have been made for iron ore upon the Alamuche mountains, but at none of these, except the Brookfield mine, has it been found in any considerable quantities.

The BROOKFIELD MINE is situated about one mile and a half southeast of the village of Alamuche. It has been worked but a few feet from the surface, and is now filled with water. The seam of ore is from three to five feet in thickness, and is divided by a layer of rock, ("horse,") from one to two feet in thickness. The ore is highly magnetic, and contains, in places, a small proportion of pyrites. It is considered an excellent forge ore.

Mines of the Wawayanda, Wallkill, Hopatcong, and Schooley's Mountain range.

The WAWAYANDA MINE is situated upon the Wawayanda mountain, in Vernon Township, Sussex County, about three-eighths of a mile southwest of the State line. At this place, there are five deposits of magnetic iron ore, four of which are worked the present time, furnishing the ore smelted at the Wawayanda Furnace.

About one-quarter of a mile farther to the southwest, on the land of Mr. J. S. Green, small openings have been made upon three deposits of ore.

The WILLIAMS MINE, situated about three miles south of the village of Vernon, is the next upon this range. The ore here is magnetic. Twenty or twenty-five years ago, it was very extensively worked; but since that time it has been abandoned. The rock, both upon the northwest and southeast side of Canisteer pond, contains much magnetic iron ore, in grains and small masses. Many have been led to make fruitless search for larger deposits in this section.

About three and a half miles west of Canisteer Pond, and two miles northeast of Upper Hamburgh, near the northwestern boundary of the Wallkill mountain, a bed, or deposit of limonite, (brown hematite,) occurs in ferruginous gneiss. It was worked for a number of years, and the ore was used at the Hamburgh Furnace. This is called the EDSALL MINE.

The OGDEN MINE is situated in the Wallkill mountains, in Sparta Township, three miles southeast of Franklin Furnace. The deposit of ore is from two to thirty feet in thickness, and has been worked to a depth of forty or fifty feet.

The VULCAN MINE, one-half mile southeast of the Ogden mine, has been worked in two different deposits of ore; one nine feet, and the other ten feet in thickness.

The SHERMAN MINE is situated three-quarters of a mile southeast of Sparta, on Slack brook. Several openings have been made, exposing the ore from three to ten feet in thickness.*

In this range of mountains in Jefferson Township, Morris Co., are the following mines, viz:

The FORD and SCOFIELD MINES, situated between three and four miles E. N. E. of Woodport. They are both in the same deposit, consisting of magnetic iron ore, varying from three to twelve feet in thickness. The Scofield mine has been worked to a depth of forty feet, and the Ford to the depth of one hundred

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* For a description of the above names, see First Annual Report on the Geological Survey of New Jersey.

and four feet. The ore is finely granular, and very compact, containing in admixture iron pyrites, hornblende, and rounded grains of apatite.

The WELDON MINE is situated on Weldon brook, two and a quarter miles east of Woodport. The deposit of ore crops out for more than half a mile on the northeastern declivity of a ridge. Numerous openings have been made into it, exposing the ore-bearing stratum from three to five feet in thickness. It is composed chiefly of magnetite, feldspar, quartz, and hornblende; in some places irregularly mixed together in about equal proportions; and in other places seams of pure magnetite, from a half to two inches in thickness, alternating with seams or laminæ of rock.

The DUFFEE MINE, about two miles northeast of Woodport. The deposit of ore is from two to four feet in thickness, and contains a large quantity of feldspar, quartz, hornblende and epidote, in admixture. This last mineral enters largely into the composition of the wall rocks.

The HURDTOWN MINE, situated about one and a quarter miles S. S. E. of Woodport; and the HURDTOWN APATITE MINE, situated one-quarter of a mile W. S. W. of the Hurdtown Forge. Mr. Wurtz describes these two localities as follows:

"We pass over to the neighborhood of Hurdtown, near the head of Lake Hopatcong. Here is a large iron mine, formerly extensively worked, but not now in operation, and therefore inaccessible for the most part. Judging from the excavation made, the bed of ore must have been, in one place at least, from thirty to forty feet in width. The strike and dip are the same as usual. Specimens were collected of the ore, from masses lying outside the mine, and a number of miscellaneous specimens picked up from the heaps of rubbish.

"The ore specimens found present various appearances; some heavy, hard and granular, sometimes exhibiting distinct cleavages; some containing considerable apatite, others a little horn-

blende; some is 'shot ore;' some specimens are jointed, the faces produced by the joints being coated with films of pyrites.

"The miscellaneous specimens include a great variety of mamillary incrustations of wax-yellow and cream-yellow chalcedony in fissures in magnetic iron, some of which are very beautiful; sometimes a lenticular mass of magnetite is enclosed in laminated chalcedony, and partakes itself of the laminated structure of the latter, while similar masses of chalcedony are in like manner enclosed in laminated magnetite.

"Other specimens are masses of translucent quartz, containing seams and strings of magnetite; mixtures of large crystals of magnetite and pyrites in feldspathic gneiss; masses of nearly pure black hornblende; magnetite with a coarse crystalline structure, and many of the faces of the crystals coated with thin folia of pyrites; seams in feldspathic gneiss, composed of mixtures of pyrites, sometimes in cubes, with magnetite in rounded nodules similar to those described below, found at the phosphate of lime locality; together with others, not important enough to occupy space in description.

"The HURDTOWN PHOSPHATE OF LIME locality. This celebrated locality is situated a mile or so in a southwesterly direction from the Hurdtown mine, nearer to the bank of the lake. Although not properly an iron mine, it evidently belongs to the same class of formations as the iron mines of this region; there is, besides, a great deal of magnetic iron at this locality, and its description is therefore introduced here.

"At the time of my visit, however, the mine was not in operation, so that the excavations were all filled with water, and could not of course be entered. My examinations, therefore, were necessarily confined to the materials lying upon the surface, from which a large number of very interesting specimens were obtained.

"The principal species of minerals found in this formation are apatite, or phosphate of lime; pyrrhotine, or magnetic pyrites;

common pyrites; magnetite, or magnetic iron; feldspar; and hornblende; occasionally, also, mica, quartz, and calcite.

"(*a.*) The apatite is found in irregular seams in a pure state, either transparent and greenish, or of a fine amber color, generally possessing the crystalline cleavage distinctly, and appearing frequently in distinct and terminated hexagonal prisms of all sizes, up to several inches in diameter. These crystals most usually, however, have rounded edges and angles. It is frequently opaque also, and stained very much with limonite, proceeding from the oxidation of the pyrrhotine with which it is usually intermixed. The most heterogeneous mixtures are found everywhere, consisting of two, three, four, or all of the minerals above mentioned, in masses and crystals of all sizes. The apatite, however, is occasionally found in masses of considerable size almost free from admixture; and consisting of a congeries of crystals of various dimensions, which have very little mutual cohesion, and such masses crumble into fragments beneath the lightest blow of the hammer. The crystals themselves also possess little solidity, cleaving with such ease that it is almost impossible to get one out unbroken. The cleavages are sometimes curved. The best crystals are usually found imbedded in masses of the pyrrhotine.

"(*b.*) The pyrrhotine is very abundant, and is very highly cleavable in structure, showing cleavages several inches across, and sometimes bent and curved. Like the apatite, it is very frangible, and cleaves with great ease. This is probably due, in part at least, to oxidation. It occurs, sometimes, in masses of large size, almost free from other minerals, but usually contains more or less apatite diffused through it, generally in the form of rounded nodules, but sometimes in crystals. A chemical examination will be made of this mineral.

"(*c.*) The common pyrites is less abundant than the pyrrhotine, and occurs mixed with the latter, and in strings, bunches, and seams, associated with every other mineral of the mine. It

was examined for copper and none found, but the analysis indicated the presence in small quantity of some other metal besides iron, and the examination will therefore be repeated as soon as time will permit.

"(*d.*) The magnetite occurs usually in imbedded nodules which are mostly irregularly spheroidal in shape, and have smooth or striated surfaces, the striæ corresponding to a laminated structure or cleavage which pervades the mass, by virtue of which it cleaves into thin plates. The similarity of this cleavage to that of the pyrrhotine, the rounded and irregular form of the nodules, and above all, the fact that it is frequently imbedded in the pyrrhotine, suggest that it is in all probability a pseudomorph after the latter. Magnetite is also found in seams and bunches in the rocks of the mine, in masses of apatite and elsewhere.

"(*e.*) The feldspar of the mine is of a rather curious and unusual character. Thus its cleavage surface O is very brilliant in lustre, much striated parallel to *i ĭ*, and has also a very curious curved or wavy appearance, the waves being apparently in the direction of one of the cleavages *I*. Such cleavages frequently appear having a diameter of several inches. The feldspar is sometimes of a greenish color and has a smoky translucency. It has occasionally a play of colors on its surface somewhat similar to that of labradorite, but as nearly as could be determined by means of the common goniometer, a difficulty being here occasioned by the wavy surfaces before mentioned, the angle O ⁚ *i ĭ* = 90 deg., and unlike labradorite it appears to be unattacked by concentrated chlorohydric acid, so that it would seem to be orthoclase. An analysis will be made.

"The other minerals of the locality do not possess any special interest. The hornblende is of a dark green color and sometimes appears in very large crystals, and is frequently mixed with a green transparent or translucent apatite. Small crystals were observed in places, which seemed to be garnets."

NOLAND MINE, situated two miles and a half southwest of the Hurdtown mine on Noland Point, Hopatcong lake. It has been worked to the depth of forty-five feet, and one hundred and sixty yards on the surface. The deposit is from three to four feet thick, and dips 70 deg. southeast. It is composed of a highly magnetic ore mixed with grains and crystals of hornblende, feldspar, and quartz. The wall-rocks are hornblendic and micaceous schists, coinciding in strike and dip with the ore deposit.

The following is an extract from Mr. Wurtz's Report on the Chemical and Mineralogical Department:

"ROSEVILLE MINE.—This mine is at Roseville, Byram Township, Sussex County, between three and four miles in a southeast direction from Andover. It has been worked at intervals for four or five years by the Trenton Iron Company. There are two principal openings, at each of which a very considerable mass of ore has been extracted, and which are both open excavations, no underground workings having yet been undertaken. The ore-bed or rather the two ore-beds, for they are most probably distinct, at these two excavations, which are about two hundred yards apart, are interposed as usual between the beds of the gneiss rock, but the horizontal axes of the two beds are by no means parallel, forming on the contrary an angle with each other of probably 45 deg. This is due to a remarkable curvature in the outcropping edges of the strata, so that while the more southerly excavation has its longer diameter in a direction of about N. N. E., and S. S. W.; the more northerly lies about N. N. W., and S. S. E. At both of the openings the walls of the beds seem vertical at the surface, but at a depth of thirty feet, which is about the depth of both excavations, the dip appears in each case to change to a steep angle towards the E., the beds at the same time becoming narrower. The forms and mode of occurrence of these two ore-beds seem to be quite anomalous, and to present an important departure from the

general rule. At the southern opening the excavation, representing of course the mass of ore which has been mined, deducting that of one or two interstratified seams or 'horses' of rock of small dimensions, is about twenty-five feet in width on an average; over thirty feet in maximum depth, and probably one hundred feet long, and here, both the N. and S. limits of the deposit (at the surface) seem to have been reached. At the N. opening, the excavation seemed a few feet wider, over thirty feet in depth at the N. extremity, and one hundred and fifty feet long. At the N. extremity of this opening at the time of my visit, ore was being broken out, and there appears, from the strong attractions found upon the surface, to be still a considerable body of ore lying in a direction N. of the present work-workings. At a point about one hundred yards to the S. of the S. excavation, another seam of ore appears but two or three feet thick, from which a few tons of ore have been taken.

"The specimens obtained include the ore found in the small seam last mentioned; ore from the S. excavation; specimens illustrating a section across the bed at the N. extremity of the N. excavation, besides a large number of miscellaneous specimens, many of which are of great beauty and interest in a mineralogical point of view, and will be ornaments to the State Cabinet.

"(1.) *Specimens illustrating the section above mentioned.*

"(*a.*) Ore from the E. side of the bed, which is a compact hard magnetic iron, mixed with considerable hornblende and some pyrites. Sometimes also it contains intermixed calcite.

"(*b.*) Ore from the middle of the bed, which is like (*a*), but with less pyrites and hornblende, and no calcite.

"(*c.*) Rock forming a 'horse' in the ore-bed near the N. wall, which is principally composed of white crystalline calcite, usually mixed with hornblende and magnetite in crystalline grains. The calcite has frequently a deeply and curiously striated surface, which gives it a columnar appearance. A soft

green mineral is also frequently present which resembles serpentine, but contains little or no water and is insoluble in acids, and may be talc.

"(*d.*) Ore from the W. side of the 'horse,' which is similar in composition to (*a*), but is granular in structure.

"(2.) *Miscellaneous specimens from N. opening.*

"(*a.*) *Asbestus*, a highly interesting variety, of a light bluish green color, with continuous fibres of very extraordinary length. One specimen obtained presents straight fibres twenty-five inches long, and a large slab, which was presented by Mr. Richard George, superintendent of the Andover mine, is composed entirely of straight fibres twenty inches long, measures fifteen inches across, and about three inches in thickness. These fibres are rather brittle, being flexible only when split up to a considerable degree of tenuity. They are sometimes much bent and distorted. A qualitative analysis showed the presence of silica, of much lime and magnesia, the former apparently in greatest quantity, small quantities of alumina and water, a trace of iron, and a doubtful trace of zinc. It frequently contains white transparent calcite diffused through it, and sometimes a large mass is composed internally of calcite, with but a superficial coating of asbestos. A complete analysis of this interesting mineral will be made.

"(*b.*) *Calcite.* This mineral occurs in various forms, in large crystals and finely granular, opaque and perfectly transparent, colorless and of a dark red color. It contains no magnesia.

"(*c.*) *Epidote;* in beautiful green crystals frequently of considerable size, imbedded in seams in a hornblendic rock which are composed of beautiful crystals of calcite, sometimes perfectly transparent, of large size, and with curved cleavage surfaces, although containing no magnesia. These are among the most beautiful specimens found at any locality during the season.

"(*d.*) *Garnet*, in small dodecahedrons of a light hair-brown color, with bevelled edges. It is generally associated with the epidote and with calcite having curved cleavages.

"(*e.*) *Mica.* The variety commonly found here has flexible and non-elastic laminæ, presenting a grey color by transmitted light. This variety forms large masses, in which the lamination is not parallel, but arranged in all directions very confusedly. Another variety is quite abundant which presents small hexagonal plates of a dark chrome-green color by transmitted light, and requires further examination. The latter generally occurs in a rock composed of a mixture of green feldspar and white calcite in crystals of considerable size.

"Other miscellaneous specimens from the N. excavation are a black crystalline hornblende rock, containing seams of pyrites a quarter of an inch wide, and other seams of crystallized calcite and garnet; a bright red colored calcite, arranged in alternate bands with the soft green talcoid mineral mentioned under (1 *c*), the whole forming a seam in translucent quartz, which is also mixed with the green mineral; a rock composed of white and dark red finely granular calcite with the above green mineral arranged in alternate bands; a rock composed of a mixture of white calcite, an olive-green translucent feldspar and magnetite, in small crystals.

"(3.) Ore from the south excavation, which is composed of irregularly crystallized grains of magnetite, mixed with a green soft altered hornblende and considerable pyrites. It has seams filled with asbestus.

"(4.) *Miscellaneous specimens from S. excavation.*

"A rock composed of calcite which presents cleavages several inches in diameter, the surfaces being striated in three directions, these three systems of striæ corresponding to three systems of parallel cleavage planes, perfectly independent of the crystalline cleavages, and easily distinguished from them by presenting dull

surfaces. The crystalline cleavages are usually curved, no magnesia being present. Masses and strings of magnetite are found in this rock, and some specimens contain a brown opaque calcite, associated with light hair-brown garnet.

"Varieties of hornblendic gneiss, one of which is entirely composed of a mixture of crystals of brilliant black hornblende and bright green epidote, presenting a very beautiful appearance; another a mixture of black hornblende and white feldspar, with seams of green epidote, and containing some calcite, as indicated by effervescence with acids; another entirely composed of brilliant black hornblende in small crystals which lie in every possible direction, making beautiful specimens.

"(5.) Ore from the opening S. of S. excavation, which is hard, compact, and contains some pyrites."

"SILVER MINE.—This locality is upon the Sussex railroad, between Andover and its terminus at Waterloo, being between two and three miles distant from the former place. The principal opening is two hundred yards or so west of the railroad. It is of small extent, and the place is only of interest from the peculiar character of the seam of ore, which is of considerable size, although from its great irregularity no distinct idea as to its width could be arrived at.

"It is really and truly a *sulphur mine*, magnetic iron being of very rare and subordinate occurrence in it, and the whole mass of the bed being made up of irregularly mingled masses, seams and bunches of pyrrhotine, pyrites, and a dark green cleavable mineral not yet made out with certainty. The quantity of pyrrhotine obtainable at this locality is quite large, if it should ever become of any value for manufacturing copperas or other purposes. The pyrrhotine is generally associated with more or less pyrites. A mica was also found here, in plates two or three inches in diameter, frequently decomposed, and one distinctly hexagonal plate was found evidently belonging to an oblique system making the species muscovite. It has cleavages at right angles to the faces I. I.

"HAGGERTY MINE.—This mine is one mile and a quarter in a northeasterly direction from Stanhope, near the road leading from that place to Hopatcong Lake. The shaft was nearly full of water so that no examination could be made of the ore *in situ*, but many interesting specimens were picked up on the surface. Among them were large masses of cleavable pyrrhotine, or magnetic pyrites like that found at the Hurdtown apatite locality, and at the Silver mine. This appears to be the predominant mineral at the locality, and occurs in admixture with magnetic iron, also cleavable, and polaric, and contains besides small nodules of phosphate of lime, sometimes transparent and amber colored as at Hurdtown, associated with pyrites in black hornblende.

"Also a dark green feldspar resembling that found at Longcore's mine and at Hurdtown, mixed with quartz, and associated with pyrrhotine.

"Pyrites in seams, irregular strings and bunches, mixed with magnetite, black hornblende and apatite.

"A micaceous gneiss, containing much feldspar, magnetite, etc., the mica having a peculiarly brilliant black lustre, and a mirror-like appearance, and its laminæ, being arranged in an approximately parallel manner, give the rock a very singular and brilliant appearance. The olive-brown color of this mica is so deep that the thinnest films are barely translucent.

"A rock composed of an intimate mixture of this brilliant mica with pyrrhotine, black hornblende, and a green quartz."

STANHOPE MINE.—The mine is situated in a ridge about seven-eighths of a mile north of Stanhope, and about four hundred yards E. N. E. of the turnpike from that place to Newton. The first workings that were made there, about sixty-five years ago by Mr. Jonathan Dickerson, are now filled in. The ore taken out at that time was smelted at the Lockwood Forge. It was afterwards worked by Mr. Simeon Dickerson. The iron from this ore was manufactured into scythes, and was considered

very suitable for this purpose. Some five years since Mr. Edwin Post made an opening from twenty-five to thirty feet in depth, about three hundred and fifty yards south-southwest of the old mine, and took out several hundred tons of ore, when it was abandoned on account of the occurrence of a vast amount of pyrites. The ore is composed chiefly of magnetite, iron pyrites and a little hornblende. In some portions of it the pyrites enters sparingly, while in others it constitutes about one-fourth of the whole.

The wall rock is hard and compact, consisting of hornblende, feldspar, grains of magnetic iron ore, pyrites, and a small portion of quartz. The first is the most abundant constituent; and the feldspar and magnetic iron ore, each compose about one-fourth of the whole.

"LOWRANCE MINE.*—This mine is situated in Roxbury Township, Morris County, one mile and a quarter N. N. W. of Stanhope. Here are one or two small openings on one of two parallel seams which were traceable by their attractions for some distance in a N. E. and S. W. direction. The holes made were so blocked up with rubbish that I could form no accurate idea by actual examination, of the nature of the formation, but from several circumstances, such as the contour of the ground, the appearance of the ore, which though pyritons, did not seem to be valueless, and the distance to which the attractions could be traced, the place was judged worthy of further examination.

"The specimens found here comprise the ore, a heavy compact magnetic iron, containing a small quantity of pyrites; and pieces of black hornblende rock incrusted with transparent opal.

The Mount Olive Mines.

"These comprise a number of openings, situated in the vicinity of Mount Olive, Roxbury Township, Morris County, a few miles in a southerly direction from Stanhope. The principal ones visited were as follows, in the order of their nearness to

* Extracted from Mr. Wurtz's report.

Stanhope: *Osborn's mine, Hilts' mine, Drake's mine,* and *Stevens' mine,* and there are a number of other openings which have been less explored, to which no distinct names have been given.

"All the seams of ore known in this vicinity were discovered at different recent dates, by Mr. Anthony A. Drake, of Mount Olive, to whom I am indebted for many of the facts given in regard to these mines. The different mines will be described in the order in which they are mentioned above.

"The OSBORN MINE is situated about three miles from Stanhope, on the road to Mount Olive. It was discovered in May, 1848, and opened immediately upon its discovery. The strike of the ore bed is from N. E. to S. W., and its dip probably 45 deg. to the S. E. The workings, which cross the road, extend to a distance of but fifty feet along the ore bed, and to a depth of twenty-five feet, the ore having been reached at the depth of nine feet below the surface, and were suspended on account of the influx of water, and want of machinery, or adequate water power in the vicinity, for pumping it out. The mine is so situated, in the midst of a nearly level expanse of country, that in any operations that may be hereafter attempted, the drainage must be accomplished by steam power. The ore-bed where opened was, at the surface, as stated by Mr. Drake, from ten to fifteen feet in width. Specimens of the ore were obtained, which is magnetic iron, mixed with considerable limonite and decomposed feldspar. It is somewhat polaric.

"HILTS' MINE.—This lies half a mile or more in an easterly direction from the Osborn mine. It was discovered in August, 1854, and was opened immediately. The seam of ore, which appears at the place where opened to be five or six feet wide, and to dip towards the southeast at an angle of perhaps 75 deg., can be traced by its attraction to a considerable distance both to the N. E. and S. W. of the opening. The shaft which was being sunk at the time of my visit, had reached the depth of

twenty-five feet. If the mine should be found worth working, it is contemplated to obtain power for pumping the mine, by erecting a water wheel on a small stream which runs through a shallow valley, a few hundred yards to the south.

"Specimens of the ore were obtained, which is a mixture of magnetic iron considerably decomposed, with a very large bulk of altered feldspar and some limonite. It resembles the ore of Osborn's Mine, though much more impure, and like it is somewhat polaric. Masses of white altered feldspar, sometimes associated with quartz and decomposed hornblende appear in great quantities among the rubbish thrown out of the shaft.

"DRAKE'S MINE—Is situated on the property of A. A. Drake, Esq., of Mount Olive, probably two miles, or more, S. W. of Hilt's mine, and was discovered in Sept., 1854. The seam of ore is on an average about five feet thick, strikes N. E. and S. W., and dips to S. E. about 45 deg. The seam has been opened to a distance of about one hundred feet, and to a depth of about eighteen feet below its outcrop. Not being worked at the time visited. Specimens were obtained of the ore, which is very strongly polaric, quite pulverulent, mixed with much decomposed feldspar and stained with limonite.

"STEVENS' MINE—Was discovered in December, 1848, and is situated probably a quarter of a mile or more S. W. of Drake's mine, on a seam of ore striking from N. E. to S. W., which seems to be about in a line with the seam of that mine. The dip is about 45 deg. to S. E., and the workings extend about ninety feet along the seam, whose width at the S. W. end of the workings is two feet, in the middle about four feet, and at the N. E. end about one foot. After going down from fifteen to twenty feet from the surface of the seam, the ore becomes so full of pyrites as to be not worth mining, so that this is the limit of the workings in depth. The specimens collected comprise the hanging wall, foot wall and two varieties of the ore.

„ (*a.*) The hanging wall is a finely granular mixture of feldspar and magnetite.

" (*b.*) The mass of the ore is strongly polaric, very frangible and pulverulent, highly decomposed and mixed with much limonite and decomposed feldspar. Some of it is, however, quite heavy and rich.

" (*c.*) A considerable portion of the ore is similar to the above, but so highly polaric as to form the most powerful loadstones that I have ever met with from any locality. A piece of about a pound in weight will lift a tenpenny nail, and if properly mounted would of course do much more.

" (*d.*) The footwall is principally composed of altered feldspar, but contains also much magnetite, and is much stained with limonite. The feldspar contained in it is apparently much more decomposed than that in the hanging wall.

" On proceeding northeast from Stevens' mine towards Drake's mine, a number of other openings are encountered, upon a seam of ore which is apparently a continuation of that at Stevens' mine, and which crosses the property of John Drake, of Mrs. Solomon, and of Charles Solomon. On the property of John Drake, where this seam of ore was first discovered in December, 1848, and where it was first opened immediately upon its discovery, immediately adjoining Stevens' mine, is an opening from which specimens of two varieties of ore were obtained, namely, from near the surface and from a few feet below, containing pyrites.

" (*a.*) Surface ore; similar to that of Stevens' mine, but containing, it may be, less feldspar.

" (*b.*) Ore from below; very heavy and dense, the pyrites being diffused through it very uniformly in small strings and bunches. It is not at all, or at most very feebly, polaric.

" The next opening, but a few yards farther northeast, is on the property of Mrs. Solomon, and the ore here is very similar to the above, but less polaric.

" Some hundreds of yards farther northeast, on property of

Charles Solomon, are several openings, and at one place two side by side, which are evidently upon two distinct parallel seams of ore. Specimens were obtained of the ore from each opening.

"(*a*.) Ore from the northwest seam; similar to that of Stevens mine and the other openings southwest of it, and may therefore be on a prolongation of the same seam, but contains less decomposed feldspar, is less polaric, and denser.

"(*b*.) Ore from the southeast seam; denser still, and more compact than (*a*), but still containing decomposed feldspar; possesses little or no polarity.

"On attentive examination of the ores of this Mount Olive district, there appears to be a great similarity in character among them. Thus they all retain indications of having been subjected to intense chemical action, being impregnated with limonite and associated with highly altered feldspar. On examination of the small opening called Stevens' mine, the only one now in operation in which the excavation has been carried to sufficient depth to expose the structure of the formation, throws considerable light upon the cause of these appearances. We there see distinctly that the whole seam has formerly been loaded with pyrites, which for a few feet below the surface, or as far as the action of atmospheric oxygen in solution in infiltrating waters could extend, has been removed by oxidation, and a quantity of limonite only left to indicate its former existence. Now, considering the large quantity of limonite found associated with all the other ores of this section, analogy leads us irresistibly to the supposition that in all probability the structure of the other seams is the same, and that after descending below a point which is probably at or about the water-level of the locality, they will be found to be pyritous to a greater or less degree.

"MARSH'S MINE.—This mine is situated upon Schooley's Mountain, Washington Township, Morris County, probably a quarter of a mile from the Heath House, a few rods to the right hand of the road leading to Hackettstown. There are two open-

ings here within a few yards of each other, from one of which ore was being taken out at the time of my visit. The deposit of ore here does not by any means present the symmetry in strike and dip which is usually found, and from the excavations I could not make out accurately the form of the deposit. Specimens were obtained of the ore and some of the associated rocks.

"The ore is a hard, compact, very tough mixture of a nearly amorphous magnetite with crystals of black hornblende, and is much stained by limonite.

"The miscellaneous specimens comprise hornblende rocks, sometimes composed of large crystals, highly pyritiferous, and covered with efflorescences of soluble ferruginous salts; a feldspathic rock, composed of large crystals, much altered and stained with limonite; an altered feldspar which presents wonderfully accurate imitations of chips of rotten wood.

"About a quarter of a mile in an easterly direction from Marsh's mine lies another opening, of small extent, called 'Dickinson's mine,' upon an ore-bed of similar character. Specimens of the ore appear to be similar to those of Marsh's mine, but contain more hornblende and are still more amorphous.

Mines of the Ringwood, Copperas, Splitrock, Hibernia, Mount Hope, Mount Pleasant, and Mount Ferrum mountain range.

The Ringwood Mines.—These mines are situated in a series of hills varying in height from one hundred and fifty to three hundred feet, and lying about one mile west and west-southwest of the village of Ringwood, Passaic County. They comprise eight distinct mines, besides several smaller openings, which were, for the most part, worked previous to the Revolutionary war, by the 'London Company,' who smelted the ore at several forges and furnaces in Passaic and Morris counties. Subsequently they passed into the possession of the Ryerson family, and in October, 1853, were purchased by the present owners, "The Trenton Iron Company," who have worked some of them very extensively since that time.

One of these mines, known as the OAK MINE, is situated on the southeastern slope of "Hope Hill," about one mile and a half northeast of the "Hard," "Blue," and "Mule" mines. It was opened by the London Company in 1762 or '63, and was, when they discontinued operations, about thirty feet deep. Afterwards Mr. Jacob N. Ryerson worked it thirty feet deeper; since which time it has been abandoned, and is now filled with water to the mouth of the level driven into it. The ore occurs in the form of an irregular deposit, occupying a vertical position, with a strike about N. E. by S. W., and a pitch in the former direction at an angle of 55 deg. It is of a black color, having a bright metallic lustre; of a compact granular structure, and for the most part quite pure, containing a small quantity of quartz and feldspar in grains, the latter in a decomposed state.

There are several openings at the south and southwest of the Oak mine, which were made by the London Company; but a comparatively small quantity of ore has, however, been taken from them. This ore is generally quite pure, and like that of the Oak mine, pitches beneath a capping of rock to the northeast. It varies in thickness at these openings from five to ten feet.

The PETERS MINE, another of the group, is situated one mile northeast of the Blue Mine, and was opened previous to the Revolution by the London Company, who worked it very extensively. They sunk several shafts, and drove in an adit-level from the base of the hill. It is estimated that they took out not less than fifty thousand tons of ore. Eighteen years ago Mr. Jacob N. Ryerson cleared out the old shafts and adit, and took out about one thousand tons of ore. The London Company, in working the mine, took out only that which contained the fewest impurities.

Another of these mines, known as the CALER MINE, is situated at the southeastern base of a low hill, half a mile northeast of the Blue Mine. It was opened by Robert Erskine,

the agent of the London Company, by whom only a small portion of ore was taken out. About four thousand tons have since been removed from it, and smelted at the furnace of Horace Gray, Esq., at Pompton. The deposit is from sixteen to twenty feet in thickness; the opening is from twelve to fourteen feet in depth, and about seventy in length. At the southeastern side of the opening is a narrow 'horse,' next to which there is ore, a few feet in thickness, very soft and much inclined to crumble. This is likewise the case with all the ore near the surface; but on descending it becomes firmer in structure, and contains fewer impurities. On the southwestern part of the opening feldspar is quite abundant; in other parts it occurs mingled with quartz; and near, and at the surface contains rounded particles of phosphate of lime. About seventy-five yards to the N. N. E., in low ground is another opening, where the same kind of ore occurs.

The New or Wood Mine, about four hundred yards northeast of the Blue Mine, was opened during the winter of 1854, by the Trenton Iron Company, who have taken about three hundred tons of ore therefrom. The deposit is twelve and a half feet in thickness, including five feet of rock intervening between its two parts, the northwestern of which is two and a half feet thick, and the southeastern five feet thick. The ore pitches down towards the northeast at an angle of 30 deg., and dips at 88 deg. to the southeast. It is of a compact, granular structure, of a black color, possesses considerable lustre, and contains a very little hornblende, together with seams of translucent quartz. The wall rock upon the southeast side, is a coarsely granular mixture of feldspar, quartz, hornblende, magnetic iron ore, and epidote. That upon the opposite side is syenite, consisting of flesh-colored crystalline feldspar, hornblende, and more or less quartz and epidote.

The Blue Mine is situated about one mile west-southwest of Ringwood. It was opened by Mr. John Ryerson, who worked

it to the depth of sixty feet, and from one hundred and ten to one hundred and fifteen in length. In 1853 the Trenton Iron Company, under the direction of Mr. Philip R. George, commenced working it, and by November, 1855, sunk a shaft to the depth of one hundred and thirty feet, at which depth it has been worked, sixty feet northeast, and fifteen feet southwest of the shaft. A tunnel was also driven one hundred and seventy-five feet in length, from the southeastern slope of the hill, striking the deposit about thirty feet below the surface. Since October, 1853, about six thousand tons of ore have been taken from this mine. It occurs in the form of an irregular deposit, with a strike about N. E. by S. W., and a vertical dip. Its thickness varies from ten to twenty feet, and is greatest about one hundred and twenty feet from the surface.

The ore is massive, of a light blue color, possesses a bright metallic lustre, and contains a small quantity of light green hornblende, with very small grains of light grey quartz. Iron pyrites also enters into it sparingly. It is traversed by joints running at right angles to the strike.

THE MULE MINE.—This mine is situated about thirty yards south of the shaft of the Blue Mine. It was opened and worked about sixty feet in length, and forty feet in depth, by Mr. Jacob N. Ryerson, but for the last twelve or fourteen years nothing has been done in it.

The ore occurs in the form of an irregular deposit, from fourteen to twenty feet in thickness, in a vertical position, and pitching beneath a capping of rock to the N. N. E., at an angle of from 40 to 50 degrees. A few feet beneath the surface, at the N. N. E. part of the workings, it divides into two branches, the one continuing in that direction, and the other turning to the north, towards which point it has been worked about twenty-five feet, and to the depth of thirty feet.

The north northeastern branch continues, probably, across the tunnel leading into the Blue Mine.

The ore is of a blue color, highly magnetic, and possessing a metallic lustre. In texture it is compact, occasionally inclined to crystalline. It is nearly free from impurities, containing a little hornblende, and near the rock capping it, a small proportion of phosphate of lime (apatite.) This latter mineral is of a yellowish white color, and of a slightly resinous lustre, and occurs in rounded particles, generally very small.

The rock capping the ore is an aggregate of grains of white feldspar partially decomposed, black crystalline hornblende, and small scales of black and brown mica. A small portion of it contains grains of magnetic iron ore, with a little epidote.

The Hard Mine.—This mine is situated thirty yards southwest of the Blue Mine, and has been worked to a depth of one hundred and seventy-five feet. Fifty feet of this distance have been sunk by the Trenton Iron Company; and at that depth they have worked it fifty feet southwest, and one hundred feet northeast of the shaft, and have taken out about fifteen hundred tons of ore, most of which has been used at Pompton. When visited, the mine was temporarily abandoned, and partly filled with water, so that a detailed and satisfactory examination could not be made at its lower portion. The general character, both of the ore and rock, with their relative position, was determined from the part exposed.

The ore occurs in an exceedingly irregular deposit, the general strike of which is about N. E. by S. W. At the shaft it is divided by an intervening rock ("horse"). Like that at all the other mines in this section, it pitches to the N. E. beneath the rock. At the southeast termination of the mine, at the junction of the ore and rock, it has been worked down at an inclination of 60 deg. It is of different degrees of purity. That from the branches of the deposit, next to the "horse," is of a bluish black color, with a bright metallic lustre, is massive and compact in structure, and contains more or less phosphate of lime, feldspar, epidote, and pale green hornblende. That from the bottom of the

shaft contains a much less proportion of these minerals. It is highly magnetic, and in some parts contains traces of titanium.

The rock of the "horse" is composed of yellowish white compact feldspar, light colored quartz, hornblende and yellowish green epidote, all cccasionally intimately mixed with scales of greyish white mica, and numerous grains of magnetic iron ore. The first three are most abundant, and in about equal proportions.

The wall-rocks vary considerable in character, though they resemble, for the most part, the rock of the "horse." In some parts the mica is quite abundant, while in others it is comparatively scarce, and unevenly scattered through the rock.

The Cannon Mine.—This mine is situated about eighty yards northwest of the Hard Mine. The intervening rock is gneiss and hornblendic slate; the former a somewhat coarse admixture of hornblende, feldspar and mica; the latter consisting of yellowish white feldspar, light grey quartz, light green hornblende, and more or less magnetic ore in grains.

Within an area of one hundred and twenty-five feet, by about one hundred, there occur not less than four deposits of ore, though doubtless some that appear to be such, are but branches of a single deposit.

The first deposit occurs at the southwestern part of the open works. It is twenty-five feet in length at its outcrop, and ten in thickness. Tne Trenton Iron Company have opened here, and taken out about two hundred tons of ore.

The second deposit is in the southeastern side of the works, and is fifty feet in length, by thirty-four in thickness. A long time since an opening was made into it to a depth of from twenty-five to thirty feet, but is now filled with water and rubbish.

The third and fourth deposits occupy the northwestern part of the open works. The extreme northwestern of these is thirteen feet thick, and sixty feet long; the other is twenty feet thick, and fifty feet long. They were opened and worked to a

depth of from twenty-five to thirty feet by the London Company.

The ore of this mine is of both light and dark blue colors, highly magnetic, of a metallic lustre, and varying in structure from finely granular to coarsely crystalline. This change in structure is observed to occur within very small limits; sometimes the granular changing to crystalline within a few inches. It is not entirely free from impurities, small proportions of quartz, feldspar, epidote, etc., entering into it. It also contains, sparingly, iron pyrites. The ore occurs also in grains arranged in laminæ through the rock, increasing in its proportion, at various places, until it constitutes the whole mass.

About twenty miles southwest of the Ringwood mines, is the Mount Hope Tract—one of the earliest opened and most extensive series of deposits in this metalliferous belt. And between the Ringwood and Mount Hope tracts, are other extensive deposits of ore, as those at Split Rock, which will be considered in a future report.

The Mount Hope Mines.

The Mount Hope mines are situated in and near Mount Hope, three miles northwest of Rockaway. There are, in all, nine deposits: four in Mount Hope, three in Hickory Hill, and two in Mount Teabo, all of which belong to the Mount Hope Company. The oldest workings are in what is called the "Open Work," "Jugular," or "Mount Hope Vein," formerly known as the Mount Hope Blue Mine. These old workings, consisting of two inclined planes, carried down at an angle of 25 degrees, to the depth of one hundred feet, are about to be cleared out and entered, by means of an adit, now being driven into them from the foot of the hill. The deposit, which at its greatest thickness is twenty feet, will average throughout about ten feet, and has a dip generally of 68 deg.

The following are extracts from Mr. Wurtz's report:

"The entrance to the mine is upon the southwest slope of the hill, and the ore has been taken out from the surface downward,

following the outcrop of the ore-bed for some hundreds of yards up the slope of the hill, to a considerable depth, and making an excavation open to the sky during that part of its course nearest the entrance, whence the name 'open workings,' or 'open cut,' by which it is known in the vicinity. The entrance to this mine, besides being very imposing in appearance, presents several phenomena which are highly instructive with reference to the structure of these formations. The strike of the outcrop is, as usual, about N. E. and S. W., and the sides of the excavation, which are of course the walls of the ore-bed, representing therefore its dip at this point are nearly, if not quite, vertical, although elsewhere the dip is steep towards the S. E., as usually the case. At the N. E. extremity of this 'open cut,' or entrance to the mine, where a portion of the ore has been left standing above the entrance to the workings beyond, this entrance being only high enough to admit the cars which run upon the tramway, it is distinctly seen that the ore-bed is stratified, the strata being parallel to those of the surrounding gneiss rock. Another phenomenon to be seen in this excavation is worthy of an allusion. The perpendicular foot wall is covered with parallel markings, or rather furrows, resembling striation on a large scale; these furrows each extending continuously along the whole visible course of the foot wall, and having a gentle inclination towards the N. E.

" The specimens collected from this mine illustrate two sections across the formation, one at the extreme northeast stopes, and the other at the extreme southwest point where the ore is accessible, or in a small excavation lying still farther to the southwest than the great 'open cut' before spoken of. Following the usual plan, the latter will be first described.

(1.) Extreme southwest stopes. The hanging wall is highly hornblendic and schistose, with interposing layers of brown mica. The hornblende is in large crystals and is somewhat altered.

"The ore is crumbly granular ("[illegible] ore"), containing a large quantity of granules of apatite, and of limonite proceeding probably from oxidation of pyrites.

"The foot-wall is similar to the hanging wall, but contains considerable decomposed feldspar and some magnetic iron. It is apparently more decomposed than the hanging wall.

"(2.) Extreme northeast slope. The hanging wall was not exposed, and its character could not be well ascertained, nor specimens of it obtained.

"Ore from the southeast side of a layer of rock or 'horse,' which here divides the ore-bed, is a heavy, hard crystalline mass, containing a few granules of apatite.

"The horse is a compact hard mass of small crystals of feldspar, with a little hornblende.

"The ore on the northwest side of the 'horse' is granular and crumbly, and contains much green hornblende and a very large quantity of apatite, much more than that on the other side of the horse. In some specimens fully half the mass appears to be this mineral. The differences in composition and structure of the two divisions of the ore-bed on opposite sides of the horse are here especially remarkable.

"The foot-wall is schistose, and composed of crystals of brown mica, black hornblende, and white feldspar, the latter predominating in quantity."

Another deposit in Mount Hope, on the southeast side, is called the "Teabo Vein," which has been but little worked. On the northeast side, towards Hickory Hill, two or three small shafts and levels have been driven into it; and on the top of the hill a shaft has been sunk on the tunnel, or adit, which is being driven from the southeast side of the hill at right angles to the deposits, in order to cut all four of them. This tunnel has already been carried past the Teabo Vein, the thickness of which, in it, is four feet.

Next to this deposit, upon the same side of the hill, is the

"Brannin Vein," upon which four or five shafts have been sunk to an average depth of thirty-five feet. This deposit is very variable in thickness, measuring in some places seventeen feet, and in others "cutting out" to one or two.

The most southeasterly deposit is called the "South Vein," and has been worked only a short distance from the tunnel. Its thickness, so far as it has been explored, is four feet.

The ore, wall rocks and miscellaneous minerals of the three last mentioned deposits have been examined by Mr. Wurtz at their intersection by the tunnel, known as the "Mount Hope Tunnel," and are described as follows:

THE MOUNT HOPE TUNNEL.—"This is the most important mining work in this vicinity. It was commenced with the intention of cutting transversely, at the lowest possible point, the 'jugular vein,' and any other seams of ore which may exist in Mount Hope, and in the course of its progress it has cut at right angles, within a distance of about five hundred feet, three ore seams, without yet having reached the main seam. Its entrance is at the foot of the hill on the S. E. side, and it forms the terminus of a railroad now building by the Company to connect with the Morris Canal at Rockaway, four miles distant. The tunnel is of sufficient dimensions to admit this railroad and ore-cars of a large size running upon it. At the time of my visit, the tunnel had been driven in as far as a seam of ore about five or six feet in width, situated five hundred and four feet from its entrance. This seam, from a supposed identity with that of the Teabo Mine, is called the 'Teabo Vein,' and another smaller seam about three or four feet wide, forming the second one cut by the tunnel, is called for a similar reason, the 'Brannin Vein.' In order not to attach too much importance to these suppositions of identity, which may not be verified by future investigation, I shall designate the three seams according to the order in which they are intersected by the tunnel; the 'Teabo Vein,' being called the third seam; the 'Brannin Vein,' the second seam,

and another small seam, but two or three feet wide, still nearer to the entrance of the tunnel, the first seam.

"Specimens were collected from this tunnel, comprising not only the ores, hanging and foot walls of the three seams, but also the rock at the entrance of the tunnel, and at two other points, three hundred and thirty and four hundred and thirty feet, respectively, from the entrance. The number of miscellaneous specimens also collected from the tunnel is large, and their character generally very interesting.

"(1.) The rock at the entrance of the tunnel is a coarse-grained schistose mixture of quartz and feldspar, the latter being very much decomposed.

"(2.) The first seam of the hanging wall is a very much decomposed feldspathic gneiss, mixed with much limonite. The cleavages of the feldspar are quite large.

"The ore is granular crumbly, and mixed with very much altered apatite.

"The foot-wall is a highly decomposed coarse mixture of large crystals of feldspar and quartz, mixed with much limonite. It is more decomposed than the hanging wall.

"(3.) Of the second seam the hanging wall is highly schistose in structure, and composed of black mica and white feldspar.

"The ore has a laminated structure, and contains considerable apatite. It contains fissures whose surfaces are polished and resemble 'slickensides.'

"The foot wall is a coarsely granular schist, composed of feldspar and quartz, containing particles of magnetic iron.

"(4.) The rock at three hundred and thirty feet from the entrance of the tunnel is a large granular, somewhat decomposed, schistose mixture of feldspar and quartz, with particles of magnetic iron interspersed.

(5.) "The rock at four hundred and thirty feet from the entrance is a schistose mixture of green feldspar, white quartz and particles of magnetic iron, containing seams of pyrites.

"(6.) Of the third seam the hanging wall is similar in appearance to the rock last described, but of finer texture and containing pyrites in numerous diffused particles.

"The ore is very hard, compact, and fine-grained, mixed with a good deal of quartz, and has a well developed jointed cleavage. It frequently contains much pyrites.

"The foot wall is similar to the hanging wall, but contains also seams of red hematite, with pyrites.

"(7.) Among the miscellaneous specimens are the following:

"A variety of specimens of pyrites, generally in seams in masses of magnetic iron, these seams being sometimes as much as two or three inches in diameter. It is sometimes associated with crystals of calcite. The abundance of pyrites in some of the rubbish heaps from the tunnel leads to the supposition that there may be seams of the rock intersected by the tunnel sufficiently rich in this mineral to be made available at some future day, whenever pyrites shall have acquired a marketable value in this country for the purpose of manufacturing sulphur and sulphuric acid.

"A schist composed of white feldspar and black hornblende, the latter predominating, containing large crystals of hornblende, and irregular masses in great number, sometimes assuming the form of rounded nodules, and presenting precisely the appearance of imbedded pebbles, of a soft green mineral, having a laminated structure resembling crystalline cleavage, but with dull surfaces. This mineral has about the hardness of apatite, for which it was at one time mistaken, but on chemical examination was found to contain but a small quantity of phosphate of lime in admixture. It will be submitted to further examination. The patches and nodules of this green mineral imbedded in the black hornblende give this rock a very singular appearance, which is enhanced by seams of green epidote, of very common occurrence in the mass, these seams consisting sometimes also of a mixture of green epidote and a brown mica.

" Masses consisting of very irregular mixtures of large crystals of apatite, sometimes several inches long and of a light brown color, with quartz, green epidote, black mica, altered hornblende, and a white calcite which has a pearly lustre and curved cleavage surfaces, but contains no magnesia. These masses occur associated with a hard, compact, schistose rock, consisting of small intermixed crystals of black hornblende and white feldspar, containing seams of epidote half an inch or more in diameter and of a beautiful grass-green color. In this rock are also found, associated with crystals of apatite, dark brown mica and calcite, a peculiar variety of pyrites in crystals, which contains copper, but is much harder than chalcopyrite. It tarnishes on fractured surfaces to bronze and irised tints. It may be a new species, and will be thoroughly examined. But the most singular mineral here found, which can scarcely be other than a new species, occurs generally intimately associated with the above mentioned pyritoid mineral. It has one perfect cleavage giving surfaces of a bright metallic lustre and lead grey color. Its streak is uncolored. Its hardness as great as that of quartz or greater, and its weight apparently not much less than that of magnetite. The imperfect chemical examinations which have so far been made, have established the existence in it only of titanic acid, alumina (?) and zinc. Fortunately one *crystal*, incomplete, though of considerable size (an inch and a half in diameter), was found, which will admit of the approximate measurement of some of the angles, and thus probably of the determination of the crystalline form. Whenever time shall permit, a complete investigation of this substance will be made.

The remainder of the miscellaneous specimens are generally of less interest; comprising seams of chalcedony associated with pyrites in magnetic iron; nodules of red hematite in an irregular mixture of quartz and greenish feldspar; a schist, some of the laminaæ of which are mixtures of magnetic iron and pyrites, others magnetic iron and green feldspar, etc.

"From a shaft sunk on the second seam of the tunnel, situated about forty yards northeast from the latter, and forty feet deep, specimens of the ore were obtained, which is a granular and crumbly ('shot ore') mixture of magnetic iron with a very large quantity of apatite in granules about the size of grains of wheat.

"On the northeast slope of Mount Hope there are a number of other mines, known by the names of the Clay Mine, Welch's Drift, Gallagher's Cut, etc., which were not in operation at the time of my visit, and time did not permit their examination. At the Clay Mine were picked up among the rubbish masses of quartz, which in places were honeycombed and full of cavities containing limonite, and frequently lined with beautiful drusy crystallizations of quartz and mammillary chalcedony. At Welch's Drift were picked up specimens of black hornblende schist, containing in fissures a transparent violet-colored mineral which is probably fluor spar, but is in too small quantity to be examined. Crystals of apatite of some size were also observed here. At Gallagher's Cut, the same violet-colored mineral was found in small quantity in fissures, and specimens of black crystalline hornblende were obtained, containing disseminated apatite, the latter sometimes in crystals several inches in their dimensions."

The Hickory Hill deposits are more to the northeast than those in Mount Hope. The workings in them are not of great extent, being chiefly levels driven for a short distance into the hill. Their average thickness, so far as opened, is three feet, with a dip of 65 deg.

* "In the elevation lying contiguous to Mount Hope on the northeast are two mines known by the names of Hickory Hill North Drift and Hickory Hill South Drift. Of these, time permitted only the examination of the North Drift. Specimens of the ore and of the two walls were obtained.

"The hanging wall is a coarsely crystalline highly hornblendic schist, containing some diffused feldspar and brown mica.

* From Mr. Wurtz's Report.

"The ore is a finely granular mixture of magnetic iron and quartz.

"The foot-wall is a very irregularly laminated schist, composed of a mixture of variously sized crystals of greenish black hornblende, white feldspar, quartz and brown mica. It is somewhat decomposed.

"About half a mile in a southeast direction from Mount Hope lies a deposit of bog iron ore or limonite, said to be of considerable extent, covering fourteen or fifteen acres of ground and having a thickness of from one to two feet. It lies but a few inches below the surface, and is mixed with pebbles and other extraneous materials in places. The railroad to Rockaway, now in process of construction, passes through the midst of it. Specimens of this mineral were collected, and a partial analysis has been made, which indicates the presence of much manganese, much less phosphate of lime than those deposits generally contain, no sulphur, no lime, and no magnesia. This result shows that this ore must be of value for mixing with some other ores, and a complete analysis will hereafter be made.

"In this connection must also be mentioned another deposit of bog ore found about one mile north of Dover, along the road to Mount Hope, on the property of Mr. James King. The appearances presented here are such as should encourage further explorations. Specimens were obtained, but no opportunity to examine them has yet been had, except to ascertain that it also contains considerable manganese.

"In the immediate vicinity of Dover, as on the meadows lying east and northeast of the village, indications of bog iron ore were observed, and future observations will undoubtedly develop many deposits of this substance throughout this whole section. The great abundance of chalybeate or iron springs observed throughout the whole of the gneiss region, of the deposits from which these beds of bog iron ore consist, shows that there must be a great quantity of it in various places. Too little attention, in

my opinion, has been paid to this ore throughout this part of the country. The manganese which it usually contains must make it of value in many cases for mixing with the magnetic ores."

On the southeast side of Mount Teabo there are two deposits, upon the property of the Mount Hope Company, both of which have been extensively worked. One of them has, however, been temporarily abandoned. Upon the other, which is called the "Elizabeth Vein," the workings consist of a level which has been driven for a distance of two hundred and forty-one feet, passing a fault of five feet. At this distance the deposit begins to rise towards the surface, "cutting out" in the bottom. Higher up the hill three shafts have been sunk, the deepest of which is ninety feet. The average thickness of the ore is six feet, and its dip 72 deg. This deposit is very curiously curved in a series of undulations, in the direction of its dip; and the dip changes every seven or ten feet. The workings upon the the abandoned deposit are said to be very extensive, consisting of three shafts about two hundred feet in depth. This deposit, like some of the others, varies considerably in thickness, being from three to eleven feet.

Teabo Mine.—Towards the southwest, and on the southwest side of Mount Teabo, is the Teabo Mine, now owned by the Glendon Company. But one deposit has been opened at this this place, though it has been worked to a great extent, the main shaft being more than two hundred feet in depth.

* "At the time of my visit it was not in operation, and although mostly free from water, not very accessible on account of the decayed and broken condition of the ladders by which the descent is made into the mine. With much difficulty, however, and at considerable risk of life and limb, specimens were obtained from the bottom of the principal shaft, about two hundred feet below the surface, comprising the hanging and foot walls, and the ore lying next to each. A number of miscellaneous specimens of

* From Mr. Wurtz's Report.

interest were also found among the rubbish around the mouth of the shaft. On account of the difficulty, or rather impossibility of access, no examination was made of the form and dimensions of the ore-bed.

"The hanging wall, at two hundred feet deep, is a micaceous schist, sometimes containing much magnetic iron in seams and bunches, and some white feldspar.

"The ore next the hanging wall is very heavy and hard, contains a few granules of apatite, and considerable quartz.

"The ore next the foot-wall is very similar in appearance, but contains considerable mica.

"The foot-wall is like the hanging wall, but more schistose in structure.

"The miscellaneous specimens are principally micaceous and black hornblendic schists, in some the hornblendic cleavages being quite large. In one was found a perfect crystal of hornblende, in the form of a hexagonal prism, derived of course from an oblique rhombic."

Allen Mine.—About half a mile southwest of the Teabo Mine are the deposits in which the Allen and Richard Mines are situated. At the Allen Mine there is but one deposit, which is, however, divided for some distance below the surface by a "horse." At the junction of the two parts the mass is twenty-two feet in thickness. A pitch towards the northeast is quite perceptible, the ore "cutting out" at the southwest end, as in the Elizabeth Drift at Mount Hope. The working of the mine is, at present, confined to the northeast end. It is entered by an adit six hundred and thirty feet in length, penetrating the hill at right angles to the course of the deposit, which at the entrance of the adit is twenty-three feet in thickness. The work has been carried on from the adit towards the northeast, for a distance of two hundred and thirty feet; and towards the southwest about three hundred and fifty feet. The thickness of the ore at the northeast end, near the bottom of the workings, is nine feet; at the southwest end, near the top, it is four feet. The dip is about 65 deg.

From this mine to the canal the distance is about two miles and a half.

* " Extensive and highly interesting suites of specimens were collected at this mine, illustrating sections across the formation at three different places; namely, at the northwest stopes, in the deepest part of the mine, just where the rock or 'horse' comes in and divides the ore-bed; at the extreme southwest portion of the mine; and at a point about intermediate between the two ends. Specimens were obtained also from the small southeast seam in the northeast workings, near the point where it thins out, illustrating a section across it, besides a very large number of curious and interesting miscellaneous specimens.

" (1.) Northeast workings, or deepest part of the mine.

" (*a.*) The hanging wall here is a very singular rock, being of a schistose structure, and apparently composed of an intimate mixture of magnetic iron with another mineral, probably hornblende, both the constituents being in very small particles. Its peculiarity consists, however, in containing numerous rounded nodules, which are composed of a greenish feldspar with mica and magnetic iron, all in small crystals; around which the laminæ of the rock are curved concentrically, thus showing them to be true pebbles, or the debris of a pre-existing rock. Some of these pebbles are themselves schistose in structure, their lamination not being conformable with that of the surrounding rock, thus indicating still another previous epoch of deposition. This rock contains frequently also large seams of brilliant pyrites, and numerous fissures and cavities which are lined sometimes with quartz crystals very perfectly formed, mixed with limonite, sometimes with incrustations of a very delicate transparent mammillary opal, sometimes with very handsome rhombohedral crystals of a pure white opaque *chalybite*.

" (*b.*) The ore on the southeast side of the bed, next to the hanging wall, is very dense, heavy, hard, pure and fine-grained,

* From Mr. Wurtz's Report.

with the jointed structure strongly developed. The two principal joints being about at right angles to each other, divide the mass into rough rectangular prisms.

"(*c.*) The 'horse,' or wedge of rock which divides the ore-bed at this point, is a compact, tough, coarsely granular mixture of feldspar and magnetic iron.

"(*d.*) The ore on the northwest side of the bed, next to the foot-wall, is crystalline, usually granular and pulverulent ('shot ore'), and mixed with some quartz.

"(*e.*) The foot-wall is a mixture of small crystals of a greenish feldspar with black hornblende and considerable magnetic iron, containing also seams of the latter mineral.

"(2.) Small seam on the southeast side of the horse in northeast workings. (*a.*) The hanging wall of this is a compact, tough, granular, crystalline feldspathic rock, containing patches of hair-brown mica.

"(*b.*) The ore is coarsely granular and somewhat crumbly, with a subschistose structure. It contains some apatite, and is feebly polaric.

"(*c.*) The foot-wall is a schistose feldspathic gneiss with considerable intermixed mica and magnetic iron.

"(3.) Section at the intermediate part of the mine. The hanging wall of the southeasterly of the two seams is a schistose mixture of small crystals of feldspar, with a little dark brown mica.

"The ore of the southeast seam is a pulverulent granular magnetic iron, mixed with quartz and granules of apatite. It is a little polaric.

"The foot wall of the N. W. seam much resembles the foot wall at the N. W. workings, but contains more mica, and less magnetic iron. Cavities were observed in it containing the same white chalybite crystals, described as occurring in the hanging wall at the N. E. workings, sometimes soft and altered, but retaining their form and whiteness. Crystals of quartz were also found in the forms of double hexahedral pyramids, and terminated hexagonal prisms, tolerably perfect and transparent.

"(4.) Extreme S. W. workings. (*a*.) The hanging wall of the S. E. seam at this place is finely granular and schistose, being almost wholly decomposed feldspar, with a few grains of limonite and decomposed hornblende.

"(*b*.) The ore of the S. E. seam could not be obtained.

"(c.) The rock separating the two seams is here a micaceous schist in a high state of decomposition, and contains some decomposed feldspar. It somewhat resembles in appearance and structure the hanging wall at the S. E. end.

"(*d*.) The ore of the N. W. seam is heavy, compact, and jointed, and is mixed with a little apatite, quartz, and decomposed hornblende. It is considerably stained by limonite.

"(5.) The miscellaneous specimens are as follows:

"(*a*.) Masses of feldspar of a greenish or greyish color, having continuous cleavages, frequently six or more inches across. Masses were found several feet in diameter, composed of almost pure feldspar, presenting throughout cleavage surfaces of these dimensions. These crystalline masses are sometimes pervaded entirely by seams of black hornblende, without in the least degree interrupting the continuity of the cleavages. The angle between the two principal cleavages, measured with the common goniometer with the greatest precision possible, seemed to be a right angle, and the mineral is therefore orthoclase.

"(*b*.) The most interesting cabinet specimens collected at this mine are masses having a regular pudding-stone structure and appearance, which are composed of sharply angular masses and nodules of crystalline granular magnetic iron, evidently the fragments of a formerly existing formation, which has been broken into pieces by violence, cemented together by a white opaque crystalline carbonate of iron or chalybite. The color of this chalybite is so purely white, and it is so generally free from all stain or tarnish, and has such a brilliant pearly lustre, that it was mistaken for pearl spar, or dolomite, until examined chemically. Cavities are found lined with beautiful rhombohedrons

of this mineral, having curved surfaces as is common with chalybite. Besides carbonate of iron, it contains small quantities of the carbonates of lime and magnesia, but is unacted upon by acids, unless boiling. It occurs sometimes associated with large masses of pulverulent limonite, probably the product of its own decomposition; sometimes also with crystals of pyrites, of the metamorphosis of which it may itself be a product. It sometimes has hexagonal plates of an olive-green mica (phlogopite?) associated with it, which have not yet been examined.

"(*c*.) A hard compact crystalline black hornblende schist, containing a little feldspar and interspersed grains of pyrites, pervaded by seams of magnetic iron and bright green epidote.

"(*d*.) Highly interesting specimens were obtained of regular fissure veins on a small scale, which pervade the magnetic iron. A transverse fracture of one of them is exceedingly beautiful, besides being very instructive with regard to the mode of formation and structure of fissure veins. Both walls are lined with a coating very uniform in thickness, of brilliant pyrites, while the centre is filled with crystalline white chalybite. In some places where the vein thickens up, crystalline bunches of quartz appear imbedded in the chalybite.

"(*e*.) A black hornblende schist, with some diffused crystals of white feldspar, containing the peculiar angular masses of magnetic iron, with large crystals of orthoclase, and nodules of green epidote.

"(*f*.) Some of the quartz contains minute particles of chalcopyrite, (copper pyrites.)

"(*g*.) A massive schist, composed of black hornblende, greenish feldspar, and magnetic iron, all these minerals being in large crystals, and the schistose structure of the mass well developed.

"(*h*.) Rhombohedrons of chalybite, with the faces covered with drusy crystallizations of quartz.

"(*i*.) Seams of magnetic iron in hornblende schist, not more

than an inch in thickness, yet having a highly jointed structure and cleavage, the planes of the joints not being exactly at right angles to the wall of the seam.

"(k.) A rock of singular appearance, which occurs in large masses among the refuse of the mine, being a mixture in about equal quantities of small masses of magnetic iron and cleavable green feldspar, from the size of a pin to that of a hazel nut, or larger. The contrast of colors produces a peculiar effect.

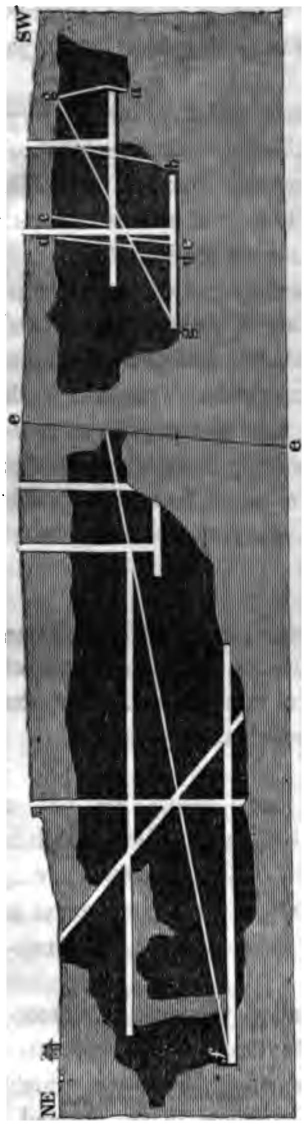
"It will be perceived from the descriptions of the different ores of this mine, that most of them are of unusual purity and freedom from the ordinary contaminations, and that they must therefore be eminently fitted for the production of the finer kinds of iron and steel wares. At the same time the quantity of these ores which have been taken away, judging from the extent of the excavation, and the greater part of which has undoubtedly been used for inferior purposes, or in short *thrown away*, must have been very great."

Richard Mine.—A few hundred yards from the Allen Mine is the Richard Mine, apparently situated in the same deposit of ore, which is here from three to five feet in thickness. The ore is finely granular, and contains small nodules of apatite.

Mount Pleasant Mine.—In the same range, and half a mile farther to the southwest, is the Mt. Pleasant Mine, which is situated in a low hill, near the junction of the Rockaway river, and the Burnt Meadow brook. It is about three quarters of a mile from the canal, to which the ore is transported by a railroad.

There are three deposits at this locality, the most northwesterly of which has been worked very extensively at its northeastern part. The great difficulty in overcoming the water, which accumulates here on account of the looseness of the ground,

Fig. 1.



VERTICAL SECTION OF MT. PLEASANT MINE, OCTOBER, 1855.

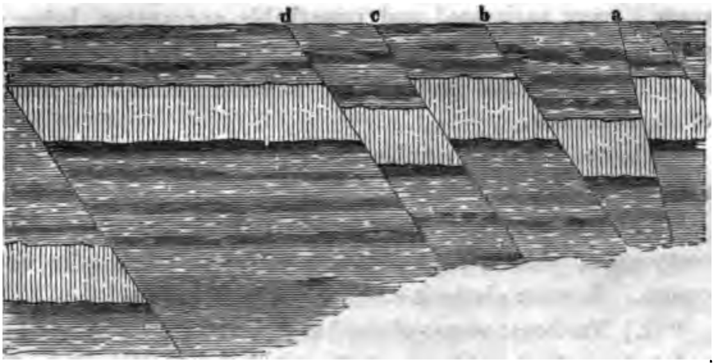
made it necessary to abandon this part for the southwest end. The working of this and of the Byram Mine is very much encumbered by faults ("offsets".) In this mine there are five, which incline at an angle of about 75 deg. towards the northeast.

The first fault *a* (Fig. 1*,) is five feet. It is at a distance of eighty-five feet from the southwest end of the mine. From this, at a distance of forty-five feet, is a second fault *b*. The third fault *c* is broken by the cross slide or fault *g*, the lower part being one hundred and seventy feet from the southwest end, and the upper part one hundred and forty feet. At a distance of thirty-five feet, *d*, is the fourth fault, also broken by the cross slide *g*. At a distance of three hundred and fifty feet from the southwest end, is the largest and last fault, *e*. It is twenty feet, dividing the northeasterly and southwesterly workings.

* This section is drawn to a scale of one hundred and sixty feet to one inch. The part in black represents the extent to which the ore has been removed; the horizontal lines represent the ore remaining; the heavy white lines the shafts and levels; and the light colored line shows the position of the faults.

"The position of these faults will be better understood by reference to the exaggerated horizontal section (Fig. 2*), in

FIG. 2.



HORIZONTAL SECTION OF MOUNT PLEASANT MINE, SHOWING FAULTS ("OFFSETS.")

which the same letters designate the same parts as represented in the vertical section (Fig. 1.) The extreme length of the workings in the southwestern end is two hundred and seventy-five feet, and the depth one hundred and forty feet. The thickness of the ore in this part is seven feet, and its average dip 50 deg. The working at the northeastern end has an extreme length of five hundred feet, and extends under the low ground at Burnt Meadow brook. The greatest depth at this end, which is at the pump shaft, is two hundred and twenty-five feet.

† "Specimens were collected of the hanging wall, foot-wall, and ore, at five places along the course of the ore-bed; namely, at the northeast stopes of the northeast workings or extreme northeastern limit of the mine; at the northeast stopes of the southwest workings; at the east and west offsets; and at the southwest stopes of the southwest workings, or extreme southwestern

* In this section, the seam of ore is represented by the short parallel lines running transversely to the section. The longitudinal scale is forty feet to one inch; the transverse scale twenty feet to one inch.

† From Mr. Wurtz's Report.

limit of the mine. A great number of highly interesting miscellaneous minerals were also found.

"(1.) Extreme northeast stopes. The hanging wall here presents a very variegated and remarkable appearance, being a schistose mixture of large crystals of a light colored feldspar with black hornblende and brown mica, sometimes containing seams of magnetic iron.

"The ore is finely granular and crystalline, mixed with considerable apatite in granules.

"The foot-wall is a thinly laminated finely granular schist, composed of white feldspar, black hornblende, brown mica, and quartz. In some places it contains seams of epidote.

"(2.) Northeast stopes of southwest workings. The hanging wall is imperfectly schistose, the laminæ being black hornblende, feldspar, and light brown altered mica.

"The ore is granular, with a few grains of a greenish decomposed mineral, which is not apatite.

"The foot-wall is an indistinctly schistose, finely granular mixture of green feldspar and translucent quartz.

"(3.) Extreme southwest stopes. The hanging wall is generally a highly crystalline mass of black hornblende, sometimes containing much feldspar, and sometimes mica and calcite. It has also frequent incrustations of calcite in fissures.

"The ore is granular and very nearly pure, containing in admixture a soft green mineral, which is probably a product of alteration of the hornblende of the hanging wall; and also sometimes incrustations of calcite in fissures. It contains also in places a few granules of apatite.

"(4.) The miscellaneous specimens comprise the following: A translucent massive quartz, which occurs in imbedded masses (small 'horses') in the ore. It is particularly interesting from containing occasional small bunches of chalcopyrite or copper pyrites.

"Apatite, or phosphate of lime, sometimes in masses six inches in diameter and having imperfect but continuous cleav-

ages, which pervade the whole mass, showing them to belong to large crystals. Several very perfect terminated crystals of apatite were also found. It is opaque and of reddish grey color, being sometimes associated with large crystals of black hornblende or irregularly mingled masses of quartz and magnetic iron. Most of the masses of phosphate of lime were found in a heap of fragments which appeared to have been taken out in excavating a shaft which has been sunk to the ore near the northeast extremity of the mine, and there may be a seam of the rock in this place containing a considerable quantity of this mineral.

" Irregular mixtures of large angular masses of granular magnetite and quartz cemented by white crystalline chalybite (spathic iron), with seams of pyrites running irregularly through the mass, containing also crystals of apatite several inches in dimensions, and forming very handsome specimens.

" A soft green mineral, columnar or subfibrous in structure, the fibres being brittle and sometimes six or seven inches long. The same mineral occurs also without the columnar structure, but apparently amorphous, and mixed with crystals of hornblende in seams in hornblende rock. Its constituents, according to analysis, are silica, lime, small quantities of magnesia and iron, with water. It is probably, therefore, a product of the metamorphosis of hornblende.

" Masses of black hornblende, with cleavage surfaces several inches across, found at the southwest extremity of the mine. A qualitative examination of this mineral indicates the presence of silica, iron, magnesia and lime, the quantity of lime, as for certain reasons I had anticipated, being apparently in much excess over the magnesia, thus making the mineral a lime hornblende. A quantitative analysis of this hornblende will be made.

" Specimens of a granular, crystalline, highly schistose rock, formed of apparently contorted laminæ of white feldspar, black hornblende and magnetic iron, the laminæ in one case being bent entirely double, a layer of magnetic iron appearing in the centre, with the others arranged concentrically around it.

"Seams and bunches of white crystallized chalybite, and ferriferous calcite, in quartz.

i. "Mixtures of apatite and quartz in large crystals, containing broad plates of hair-brown mica, in fissures in feldspathic gneiss. Two or three small crystals of zircon were also found at this mine.

"The feldspar crystals of this mine were examined to determine their species. Three cleavages were found, the two most distinct, O and *i* *i*, giving with the common goniometer an angle of 90 deg., thus making the mineral orthoclase. The third made with *i* *i* the angle 90 deg., and supposed therefore to be *i* *i*, but O : *i* *i* was found to be 121 deg. instead of 116 deg. 7 min., as it should be in orthoclase. The examination will be repeated."

Huff Mine.—The Huff Mine, which is next in a southwesterly direction from the last named, is not upon the same range, but a quarter of a mile northwest of it. There are three deposits here, all of which, although formerly more or less worked, are now abandoned. Near the Washington Forge pond, about a quarter of a mile from this mine, and like it aside of the general range, is the Burwell Mine, which is also abandoned.

The next deposits that occur in a southwesterly direction from this locality are those of Irondale, beginning within a quarter of a mile of the canal bank. On the first of these is the Harvey Mine, which has not been worked for several years; then succeeds the North River Mine, apparently upon the same deposit in which the Hubbard Mine is situated—a deposit remarkable for dipping at a lower angle than any other in this section, namely at 30 deg. The seam or deposit of ore is from two to eight feet in thickness, and has been worked to the depth of seventy feet. Southwest of this are the Stirling, Spring, and Sullivan mines.

The deposit of ore in which the Stirling mine is situated, is from six to sixteen feet in thickness, including several small

seams of rock ('horses'). It pitches beneath a capping of rock towards the northeast, and dips towards the southeast at an angle of 45 deg.

"Within a quarter of a mile of the Stirling, is the Corwin Mine, which like the Huff and Burwell Mines, is a short distance to the northwest of the regular range, apparently upon a different and parallel series of hills. The ore has been taken out on this deposit, for the distance of about three hundred yards. The workings at the northeast end extend to the depth of ninety feet, when they run out to the surface at the southwest end."

Mr. Wurtz has described the Corwin, Stirling, and Hubbard Mines as follows:

"Corwin Mine.—The seam of ore which dips to the S. E. at an angle of about 45 deg., is from five to eight feet in thickness. Two shafts have been sunk at this place, seventy-five feet apart, and the ore is opened to a depth of about one hundred feet. Specimens were procured at the bottom of each of these shafts, of the hanging wall, foot wall and ore.

"(1.) At the bottom of the N. E. shaft the hanging wall is a schistose, small granular rock, the laminæ of which are sometimes contorted. Its constituents are generally black hornblende, and a white or green feldspar, the latter predominating, with a little dark brown mica disseminated; some laminæ, however, consisting entirely of black hornblende, or of magnetic iron.

"The ore is apparently similar to that at the S. W. shaft, described below, but unlike that containing little or no pyrites intermixed, this latter being replaced by specks of limonite, or hydrated sesquioxide of iron, indicating the oxidation of the pyrites, and removal of the sulphur. Some specimens contain much phosphate of lime intermixed.

"The foot wall is a thinly laminated, coarsely crystalline schist, composed of quartz, green feldspar and black mica, in-

termixed in places with much magnetic iron; sometimes partially decomposed.

"(2.) At the bottom of the southwest shaft, the hanging wall is coarsely schistose and small granular in structure, composed of quartz and green feldspar, the latter predominating in quantity. Some laminæ contain much magnetic iron.

"The ore is finely granular and crumbly, ('shot ore') containing disseminated specks of pyrites, and numerous small specks of phosphate of lime.

"The foot wall is small granular and highly schistose, composed of a white feldspar, black or brown mica and black hornblende, with a few specks of pyrites, and in some places much magnetic iron.

"STIRLING MINE.—It is one of the most important mines in this section, and has been and still is very productive of ore. The seam of ore is irregular in width. The workings extend along the seam for a distance of three hundred feet, and at the deepest part of the mine, which is at the middle stopes, the ore has been exposed to a depth of one hundred feet from the surface. The strike of the seam is as usual about N. E. and S. W., and its dip, following that of the beds of gneiss between which it is interposed, is variable, being in some places 45 deg. or more, while in others not more than 30 deg. Specimens were collected of the ores at the two extreme ends of the mine, as well as in the middle stopes, or deepest part of the mine, together with the adjacent walls, wherever it was possible, the foot walls at the N. E. and S. W. stopes being inaccessible at the time of my visit; also of a 'horse' which occurs here.

"(1.) At the extreme N. E. workings the hanging wall is a highly decomposed schistose rock, composed of small grains of feldspar, with some quartz and a few grains of magnetic iron intermixed.

"The ore is very crumbly, granular ('shot ore'), much stained

with limonite, and mixed with very much of a pulverulent white substance, which is apatite in a highly altered state. It has a jointed structure, and a very feeble, scarcely perceptible polarity.

"(2.) At the middle stopes, the ore is a mixture of granular magnetic iron with much phosphate of lime in granules and nodules. It partakes very highly of the character of 'shot ore,' being easily crumbled to a coarse powder between the fingers, although apparently compact in the mass, and presenting no indications of the least decomposition. It has an imperfectly jointed structure and is feebly polaric, though more so than the ores from the two extremes of the mine.

"(3.) At extreme S. W. workings. The ore is precisely similar to that at the other end of mine, though probably less impure, and not so much decomposed.

"(4.) The 'horse' is a rock of peculiar appearance. It is strongly schistose in structure, some laminæ being composed of coarse crystals of feldspar of a dark color, black hornblende and magnetic iron; others of a mixture of feldspar, quartz and magnetic iron; others still of a mixture of magnetic iron with a very large proportion of phosphate of lime, the latter forming more than half the mass. In this rock were observed imbedded masses in the form of rounded nodules, apparently feldspar, and having a distinct cleavage, resembling those found at the Mount Hope Tunnel.

"Hubbard Mine.—The seam of ore is but from four to four and a half feet thick, its course being about as usual, N. E. to S. W., but its dip much less than usual, or only 30 to 35 deg. from the horizontal. Specimens were obtained of the hanging wall, foot wall and ore.

"The hanging wall is a coarsely schistose mixture of large crystals of quartz, magnetic iron and hornblende, the latter min-

eral predominating, and the two latter somewhat altered by oxidation.

"The ore is a granular mixture of magnetic iron and phosphate of lime, the granules of both being very small. It has a jointed structure.

"The foot wall is a coarsely crystalline mixture of quartz and feldspar, the latter predominating; sometimes intermixed with magnetic iron. The schistose structure is not apparent."

About a quarter of a mile southeast of the Stirling Mine, is the Jackson Mine, and about a quarter of a mile southwest of the Jackson Mine, is the Randall Hill Mine, situated apparently in the same deposit, the latter being somewhat nearer the summit of the hill. While at the Randall Hill workings there are two deposits, only one has been opened upon at the Jackson Mine. At Randall Hill, the workings were the more extensive of the two, and at one time a steam engine was employed to pump water here through a shaft nearly three hundred feet in depth. Both of these mines are, at present, abandoned.

In a southwesterly direction, at the distance of a quarter of a mile from the Randall Mine, and about one hundred yards south of the road from Dover to Stanhope, is the MELLEN MINE. This mine has been also, for the present, abandoned.

The following are extracts from the report of Mr. Wurtz:

"The seam has been worked from northeast to southwest about forty-five yards, and throughout this distance it preserves, like that of the Byram Mine, considerable regularity of form, being usually about two feet thick near the surface, and gradually widening to five feet towards the bottom, the mine being about one hundred and thirty feet deep. The dip is towards the southeast, as usual, and very steep. The specimens collected were as follows:

"(1.) The hanging wall at the extreme northeast stopes of

the mine; a mixture of partially decomposed feldspar with quartz, containing considerable magnetic iron.

"The ore at the same place, which is heavy, of columnar structure, and contains interspersed nodules of altered apatite.

"The foot-wall at same place; very similar to the hanging wall, but contains less quartz and magnetic iron, and is more decomposed.

"(2.) A small 'horse' found in the seam of ore; a fine-grained mixture of light bluish feldspar with small quantities of black mica, quartz and magnetic iron. It is not so much decomposed as most of the other rocks found at this mine.

"(3.) The wall of a small 'offset,' or fault in the strata, which displaces the seam of ore a few feet, and which is composed of a decomposed feldspathic gneiss.

"(4.) The hanging wall in extreme southwest stopes; a mixture of bluish feldspar, partly decomposed mica, and magnetic iron.

"The ore in same place; mixed with altered apatite and other minerals, and containing seams of decomposed hornblendic gneiss.

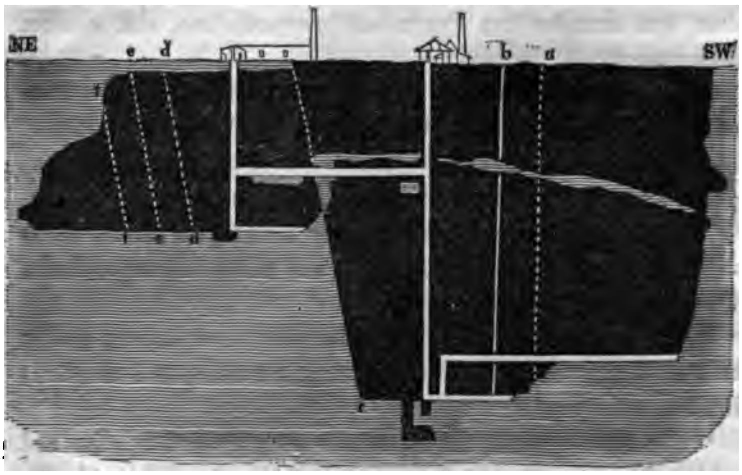
"The foot-wall at same place; a mixture of feldspar with small scales of black mica. Very much decomposed, much more than the hanging wall.

"Miscellaneous specimens, comprising crystalline mixtures of feldspar with quartz and magnetic iron, the latter frequently oxidized or partially so, and sometimes in the form of seams traversing the rock, which show very well the junction of the ore and rock, the two being much mixed at the point of juncture; also a schistose rock composed of white altered feldspar and quartz, with seams and bunches of magnetic iron, some laminæ containing decomposed brown mica."

BYRAM MINE.—On Mount Ferrum, about five hundred yards southwest of the last mentioned mine, is the Byram mine. This

deposit of ore, although more regular than most of the deposits in this metalliferous belt, is very much dislocated by faults ("offsets"). The accompanying vertical section (Fig. 8) repre-

FIG. 8.



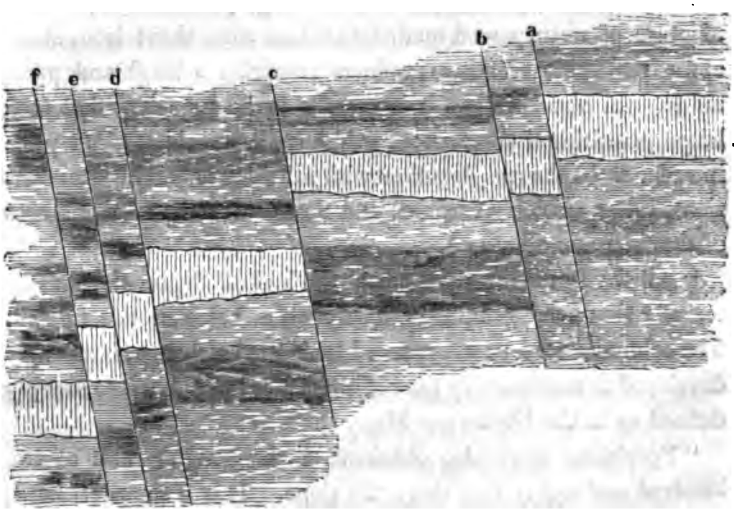
VERTICAL SECTION OF BYRAM MINE, OCTOBER, 1855.

sents the extent to which the deposit has been worked. The inclined plane at the southwestern end is two hundred and sixty-eight feet in length, and, as the dip of the deposit is 50 deg. this makes the bottom of the mine about two hundred feet below the surface. This end of the mine is separated from the north-east end by a fault of fourteen feet, and has been worked for a distance of three hundred and thirty feet southwest of it. The north end has been worked from the fault for a distance of two hundred and fifty feet.

The faults in this mine are six in number. The first *a* (Fig. 8), at the distance of one hundred and thirty feet from the south-west end of the mine, throws off the deposit five feet to the north-

west; the second *b*, thirty-six feet from this offset, throws it off one foot and a half in the same direction; the third *c*, one hundred and fifty-three feet from the second, throws it off fourteen feet; the fourth *d*, one hundred and ten feet from the third, throws it off six feet; the fifth *e*, twenty-nine feet from the fourth, throws it off five and a half feet; and the sixth *f*, twenty-seven feet from the fifth, throws it off eight feet, which is exactly the thickness of the deposit. The letters on the horizontal section (Fig. 4) refer to corresponding parts in the vertical section.

FIG. 4.



HORIZONTAL SECTION OF BYRAM MINE, SHOWING THE POSITION OF THE FAULTS ("OFFSETS").

This mine is one mile and a half from the point on the canal at which the ore is shipped.

Extract from Mr. Wurtz's report:

" The ore of this mine appears to contain, on an average, more apatite than that of the Dickerson Mine, and specimens were frequently met with which seemed to contain more of this mine-

ed, in bulk, than of magnetic iron, although of course much less in weight. Specimens of the ores were obtained from the lowest workings, two hundred and eighty feet down the slope, comprising average samples of the ore, which seemed to be granular mixtures of magnetic iron and apatite, and of the picked ore, which was the same, except in containing less apatite. A great deal of this picked ore might be considered as very nearly pure magnetite, and there can be no doubt that by proper processes of washing, or treatment by magnetic machines, a large proportion of this ore, as well as that of the Dickerson Mine, might be obtained in an exceedingly pure form, highly fitted for the manufacture of unsurpassed qualities of iron wire, sheet iron, steel, and a multitude of other products requiring a tough and pure metal. In view of this, it is greatly to be regretted that such large quantities of these ores should have been sold at a low price in order to be thrown, together with all their natural contaminations, into a smelting furnace, and thus forever lost for purposes of the finer manufactures.

"All the Byram ores possess in the highest degree the character of 'shot ore,' crumbling easily even between the fingers. The columnar structure, produced by jointed cleavage, is strongly developed in nearly every part of the bed, although not so sharply defined as in the Dickerson Mine.

"Specimens were also obtained of the hanging wall at two hundred and eighty feet down the slope. It is a compact, hard, crystalline granular rock, composed principally of a greenish feldspar, with disseminated particles of magnetic iron, and of pyrites, and sometimes some specks of a hair-brown mica; also of the foot-wall at the same point, which is similar in appearance, except that it contains no pyrites; also of a small 'horse' which penetrates the bed at the southwest workings, which is composed of a coarsely crystallized mixture of greenish feldspar and magnetic iron, sometimes subschistose in its structure; also

of the ore taken from one of the columns left to support the hanging wall, at eighty feet down the slope, which is much purer than that at the bottom of the mine, but is much mixed with the remains of decomposed feldspar, and superficially stained brown by limonite."

Brotherton Mine.—About a quarter of a mile further to the southwest is the Brotherton Mine, which is not at present in operation.

Extract from Mr. Wurtz's report:

"No machinery for draining having been erected, the formation has not yet been penetrated to a sufficent depth to show its structure with any reliable accuracy. Specimens were collected of the hanging wall, foot-wall, and ore.

"The hanging wall is a slightly decomposed hard feldspathic schist, containtng some quartz, and interspersed with grains of magnetic iron ore.

"The ore is a mixture of magnetic iron, with much decomposed feldspar.

"The foot wall is similar to the hanging wall in appearance, but more schistose, less compact, and more finely granular in structure, and much more decomposed."

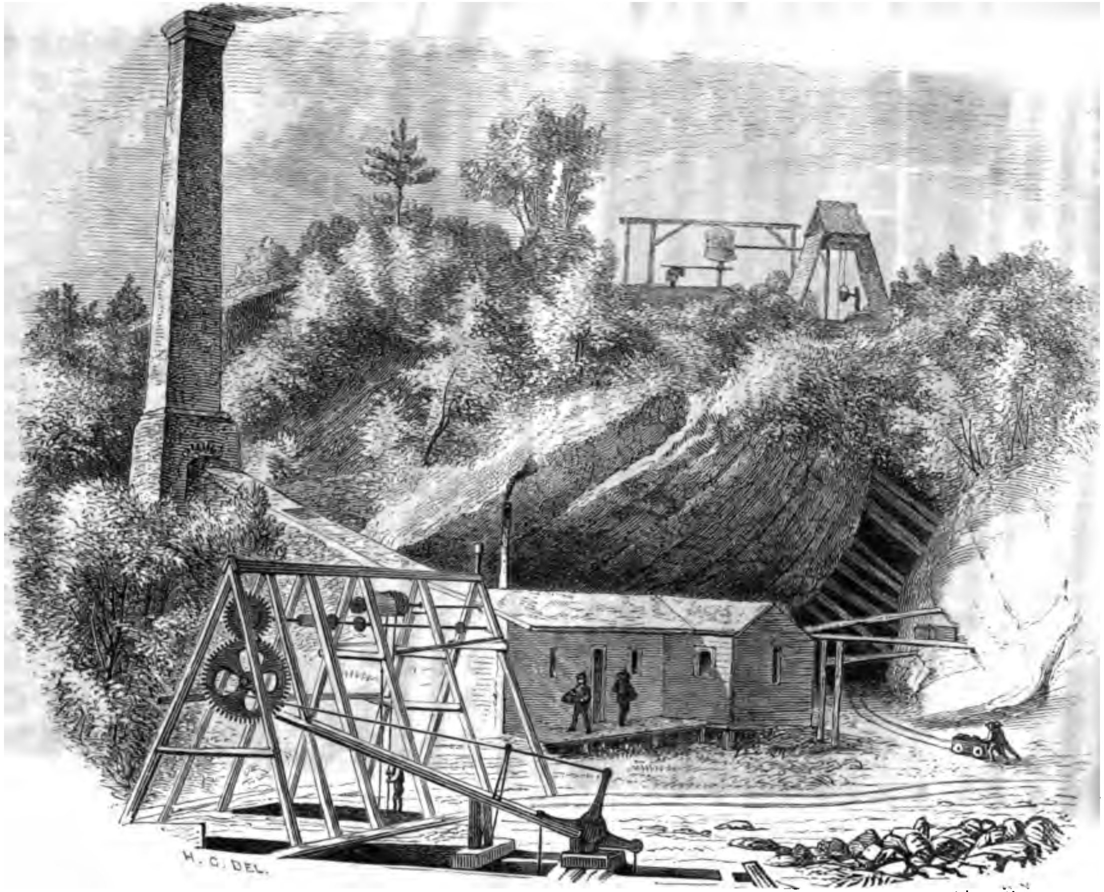
Dickerson Mine.—In the order of distance, though not of range, the Dickerson Mine is next to that last mentioned; and like some others already noticed, it is situated one third of a mile northwest of the general direction of the series. This mine is said to be the oldest in the iron region of Morris County; and has been celebrated throughout the State for furnishing a superior ore for forge purposes. The tract of land including the mine was taken up as early as 1713, by Joseph Kirkbride. In 1807, the late Hon. Mahlon Dickerson became its owner, and worked it until the time of his decease, three years ago. In 1853, the Dickerson Succasunna Mining Company purchased it,

and have erected a steam engine, and made other preparations for the most extensive operations. The accompanying view and

Fig. 5.

VERTICAL SECTION OF DICKERSON MINE, OCTOBER, 1855.

section will give some idea of the appearance on the surface, as well as the extent of the underground workings. The view represents the outcrop of the ore deposit, the stratification of the hanging wall rock, the engine housé, horse whim, and machinery for pumping and hoisting. The section exhibits the extent of the underground workings. The deepest part of the mine (N. E. workings), called the "old mine," has been abandoned. It was worked by three shafts, sunk to the depth of about two hundred feet below the present surface, which, at this point, is about twenty five feet lower than the original surface of the hill. These workings are two hundred and seventy three feet in extreme length on the bottom. The ore, in some places, in this part of the mine, measures thirty feet in thickness; but at the extreme northeastern brest, it is only three feet. That part of the mine which is at present worked, has been sunk to the depth of about one hundred and seventy feet below the surface. At this depth, the shaft has not struck the "horse" *c*, the



DICKERSON MINE, MOUNT FERRUM, MORRIS CO.

distance from the bottom of the shaft to the "horse," as at present exposed, being forty feet. The thickness of the ore at the northeast brest *b* of this part of the mine, is also three feet; the greatest thickness at *z* is thirty feet. Four or five shafts have been sunk on the outcrop of this deposit, at the top of the hill, but none of these workings are of much extent. This deposit of ore, like many others described in the preceding pages, pitches beneath the rock towards the N. E., while its S. W. extremity is underlaid by it.

Extracts from Mr. Wurtz's report:

"There is here an immense, somewhat irregularly shaped cake or lenticular mass of magnetic iron ore, lying imbedded in the gneiss rock, its longest diameter coinciding both in strike and dip with the direction of the bedded structure or stratification of the gneiss. In the direction of this longest diameter it thins out, at nearly every point where its limits have been reached, to acute edges, such edges being sometimes split into two by wedge-formed masses of the rock, which sometimes penetrate to a considerable distance into the mass of the ore, thinning out also usually to acute edges. These interpenetrating masses of rock are called, in the language of the miners, 'horsers,' or 'horses,' probably from some occasional fanciful resemblance of their upper acute edges to a horse's back. The direction of their longer diameter is usually parallel to the stratification or schistose lamination of the rock forming the walls of the mass of ore, and therefore parallel also to that of the ore itself. They frequently have well defined walls on their sides, the rock forming the horse not being mixed with the ore in which it is imbedded, nor the ore mixed with the minerals forming the rock of the horse, at the point where they come in contact. The mass of ore, especially in places where it is thin, or where the walls approach each other, has frequently a jointed or columnar structure, the directions of the planes of the joints being at right angles, or nearly so, to the walls, and crossing one another at various angles.

Some measurements were made of these angles between the planes of the joints with a Hauy's goniometer, and gave 77¼ deg., 105¼ deg., 110½ deg., 94 deg. This jointed structure is, generally speaking, most highly developed where the ore is most free from impurity. The appearance of the great mass of the ore of this mine is that of a very pulverulent, though closely compacted mixture of small irregularly angular grains of magnetic iron ore, or magnetite, with small rounded granules of phosphate of lime or apatite. Such ore is called by the miners 'shot ore,' from its crumbling easily into small fragments from the size of a small shot up to that of a pea. This property is not to be attributed to any effect of partial decomposition, for ore which has apparently never been subjected to the action of water or air, possesses it. The proportions of the two principal ingredients of the ore are very variable, but the phosphate is always the smaller in quantity. Its average proportion, as shown by a partial analysis that has been made, is between nine and ten per cent. The ore is very rarely found in crystals. A single specimen containing distinct octahedrons, with much striated faces, was found imbedded in a soft green mineral of columnar structure, occurring in a seam in the foot wall, near the principal entrance to the mine.

"As before remarked, the general inclination of the bed of ore is that of the beds of the surrounding gneiss rock, which is here usually at a steep angle to the S. E. The wall of rock on the S. E. side of the ore is accordingly called by the miners, the 'hanging wall,' and that on the N. W. side the 'foot-wall,' as is done in the case of regular metalliferous veins, which this formation does not in any other respect resemble; but the terms being nevertheless convenient, and not particularly objectionable, we shall adopt them. The inclination of the ore-bed follows the contortions and irregularities of the gneiss; thus, in some places, the axis of the deposit, instead of dipping to the S. E., is more nearly vertical, and even dips sometimes to the N. W. On an-

thority of the gentleman in superintendence of the mine, Mr. Canfield, it may be stated that the ore upon the side of the bed nearest the 'foot wall,' is usually the purest. The general course of the horizontal axis of the ore bed is very accurately N. E. and S. W., or parallel to the upturned edges of the beds of the metamorphic schists all through this part of the State.

"From this mine were collected for the various cabinets, suites of specimens of the ore now being taken out, with specimens of ore showing the jointed structure, and of several other varieties; of the hanging wall, foot-wall, and a large 'horse,' which penetrates the mass of ore in the S. W. workings, at a place where it is more than thirty feet thick. This spot is about one hundred and eight feet below the surface, in the S. W. workings, near the point where the ore is at present being taken out, from which point the other specimens above mentioned were taken. Specimens also of hornblende and various other miscellaneous minerals were selected.

"The hanging wall is a rock composed of a mixture in about equal proportions of feldspar and quartz, in small grains.

"The average ore has already been described, as also that showing the jointed structure most strongly.

"The foot wall is a mixture of hornblende, feldspar, dark colored mica and quartz, the two former much decomposed.

"The 'horse' is very similar to the hanging wall, but somewhat more finely grained.

"The miscellaneous specimens, which are not particularly interesting at this mine, comprise crystals presenting large cleavage surfaces, frequently several inches long, and one inch broad, which are supposed to be hornblende, but have a very much less hardness (possibly proceeding from alteration); also different varieties of schistose rocks, one of which is a mixture of a dark olive-colored mica, with much apatite, magnetic iron, and incrustations of a transparent or translucent soft green mineral, which contains silica, lime, a little magnesia and sesquioxide of iron,

with water; another is composed of layers of magnetic iron, alternating with brown mica, and containing nodules of quartz. There are also mixtures of brown and brownish-olive mica with hornblende, the latter somewhat decomposed; and specimens of hornblendic gneiss, containing magnetic iron, which are incrusted with a brown substance, of crystalline appearance under the magnifier, and which, according to analysis, appears to be a hydrated silicate of magnesia, stained by manganese."

KING MINE.—A quarter of a mile to the southwest of the Dickerson Mine, is the "King Mine," which is opened to the depth of thirty feet. The hanging wall rock here is gneiss, distinctly stratified, and composed of quartz and feldspar. Three layers of ore are exposed, each one separated from the other by layers of rock, as follows:

1st, a layer of ore four feet thick, highly magnetic, columnar, and containing apatite; 2d, intervening rock, micaceous slate in thin laminæ; 3d, ore eight feet thick, and of the same character as that of 1; 4th, rock in laminæ composed of feldspar, quartz, and a small quantity of mica; 5th, ore, feldspar, and quartz in admixture; 6th, foot-wall. The dip of the deposit is 54 deg.; its strike N. E. by S. W.; its pitch towards the N. E. at 50 deg.

The view on the next page represents the relative position of the two upper layers of ore, with the intervening rock and wall rocks. It also exhibits the columnar structure of the ore, and the stratification of the rock.

LOGAN MINE.—The last deposit in this range that has been worked to any great extent, is on the property of Mr. C. S. Dickerson, and was formerly designated as the Logan Mine. It is about two and a half miles from the Dickerson Mine, in a southwesterly direction. There are two deposits here, fifty feet apart, of which the larger, or southwesterly, only, has been

from two and a half to three feet thick, and is a friable schist, composed of greenish feldspar, black hornblende, and brown mica. These minerals are variously associated; in some places occurring in large crystals, and irregularly mixed; again in small irregular grains, interlaminated with each other, forming a perfect schist; and in other places, as on the summit of the ridge between the Glendon and Upper Wood mines, occurring in large, irregular masses, varying from half an inch to more than a foot in diameter, of pure feldspar, quartz, mica and granular magnetic ore. The layer of rock 3 is from sixteen inches to two feet thick, and is a hornblende schist, simliar to the rock 2, both in its structure and composition. The rock 4, constituting the hanging wall of the deposit, is a fine grained, hard, crystalline hornblende schist, composed of black hornblende, white feldspar, and quartz, containing sparingly, in admixture, small scales of brown mica, and minute grains of magnetic ore.

Fig. 7.

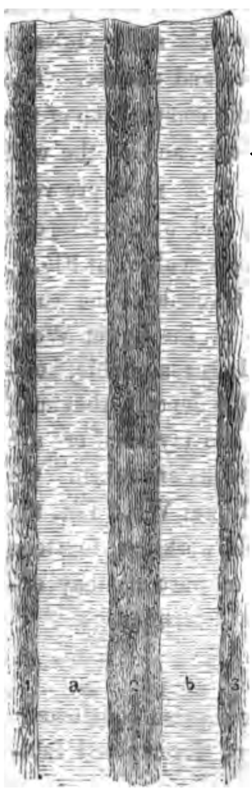


Fig. 7 represents a transverse section of the deposit in the Glendon Mine, about half way between the extreme northeast and southwest workings, or midway between the Lower Wood and Willis mines. Two layers of ore, *a* and *b*, are here exposed, *a* being eight feet, and *b* six feet in thickness, and separated by a layer of hornblende schist five feet thick. This ore dips to the southeast, at an angle of 86 degrees, and has been worked to the depth of one hundred and twenty-five feet.

FIG. 8.

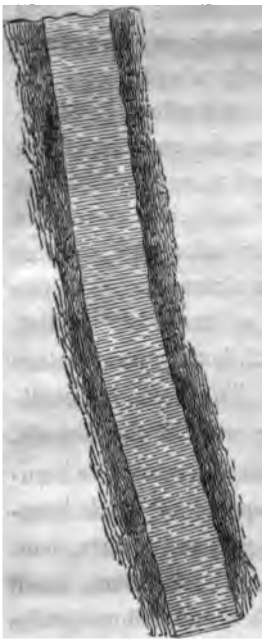


Fig. 8 represents a section of the deposit at the most northwesterly workings, at the Willis Mine. The ore dips, first, at an angle of eighty-one degrees, and again, about thirty feet from the surface, at an angle of seventy-three degrees. Only one layer of it has been exposed and worked, the average depth of which is sixty-five feet, with an average thickness of seven feet. This ore is granular and very friable, columnar in structure, and highly magnetic, interspersed throughout with crystals and nodules of greenish hornblende, and apatite. The general character and composition of the different layers of ore, and of the wall and intervening layers of rock, are very similar throughout, and will correspond with the description given above at Fig. 6. Whether these three layers of ore extend throughout the whole deposit, and are of the same character as at the Lower Wood Mine, is not yet positively determined. It is reasonable, however, to infer, from the great regularity of the deposit, that such is the case. In some parts of the deposit the layers of ore are much thicker than those from which the sections are taken. On the southwestern slope of the ridge, on the Lower Wood Lot, the ore of the three layers is exposed in the old workings, fourteen feet in thickness. How far this thickness of pure ore may extend, future explorations and workings must determine.

Extract from the report of Mr. Wurtz:

"MISCELLANEOUS SPECIMENS.—These comprise conglomerates of angular fragments of magnetic iron, decomposed feld-

spar, mica, etc., with cavities filled with botryoidal crystallizations of pyrites, (these conglomerates are similar to those described as occurring at the Allen Mine, but the cementing material in this, instead of chalybite, is merely calcite, somewhat ferriferous); crystals of feldspar, which when broken across, present in section zones of different colors, such as white, greenish and violet, proceeding from different degrees of alteration in composition, by the action of water and air, associated with small hexagonal prisms and plates of mica (phlogopite ?); seams of white calcite in micaceous schist, which contain transparent green and violet fluor spar, of beautiful tints, and crystals of quarts in the form of regular double hexahedral pyramids; a rock composed of nearly pure black hornblende in large crystals; mixtures of salmon-colored feldspar and green hornblende in large crystals; small hexagonal plates and prisms of hair-brown mica, associated with quartz and green needles of tremolite, in seams of altered feldspar in magnetite; crystalline nodules of apatite, half an inch in diameter, in magnetite; white incrustations on gneiss, with a soapy feel, but containing much carbonic acid; chalcopyrite associated with the above described variegated feldspar and hexagonal plates of mica in magnetite; seams of a flesh-colored calcite, presenting curved cleavages, in hornblendic schist. One crystal of sphene, about three-fourths of an inch in diameter, was found imbedded in calcite, and associated with the angular cemented masses of magnetite above spoken of. It gives the reactions of titanic acid before the blow pipe. It appears to be somewhat altered, and few of the faces possess their original polish, so that satisfactory measurements could not be made of the angles."

The accompanying map, profile and sections, show the position and extent of the deposit, as far as it has been worked above water level, also the manner in which it as been mined, and the extent to which the ore has been extracted; although in a great-

er part of the workings, only one of the layers has been removed, leaving one, and, in some places, two layers still unworked.

This deposit has not, as yet, been mined as it should be, because of its many divisions into mining lots controlled by different persons. The upper mines of the tract, viz: Glendon, Upper Wood and Willis, are worked by means of shafts sunk into the deposit, through which the ore, as well as the water, is raised. This mode should be resorted to, especially when the price of iron is so low, only in those cases where the position of the deposit will not admit of an adit level, through which the ore and water may be removed without the expense of machinery, for hoisting and pumping, which often increases the cost of mining a ton of iron to its full value.

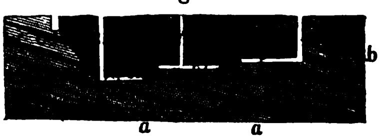
The key or great outlet to this large and valuable deposit of ore, is the Lower Wood Mine, situated on the southwestern slope of the ridge. By means of levels driven into the deposit from this slope even with the water level, and connected together by shafts and winzes, for ventilation, and passage ways for ore, from a higher to a lower level, this whole deposit, above water level, might be removed and landed at the foot of the slope, without the great expense of hoisting and pumping.

A railroad route has been surveyed and located, which extends from the canal, at Rockaway, to the Lower Wood Mine, three miles and a quarter in length, and with a gentle grade, the adit level of the Wood being but forty-seven feet above the canal. Thus it will be seen that this tract possesses unusual advantages for extracting the ore from the deposit, as well as for transporting it to the banks of the Morris Canal, one of the principal channels of communication with the iron smelting and manufacturing works in this State and Pennsylvania.

Beach Mine.—This mine, although it is generally included among the mines of the old Hibernia Mine tract, the general character of its ore and wall rocks being the same, is situated

three-quarters of a mile southwest of the Lower Wood Mine, on a ridge that rises abruptly from the northeast, to a height of five hundred and twenty feet above Hibernia brook. The outcrop of the deposit of ore is situated in the northwestern slope of the ridge, twenty feet below its summit. The deposit averages three and a half feet in thickness, and dips at an angle of 80 degrees. It is a hard, coarse grained magnetic ore, interspersed with nodules and imperfect crystals of apatite and greenish hornblende. The general character of the wall rocks is a hornblende schist, varying considerably in structure and composition. A light green asbestus, in fibres of several inches in length, occurs frequently in the hanging wall rock adjacent to the ore. Calcite in seams, and crystals (dog tooth spar) occur, associated with black hornblende and greenish feldspar. The accompanying section, (Fig. 9), represents the extent of the workings, and the location of the faults. The ore has been removed in the deepest shaft, to the depth of fifty-five feet, and one hundred and ninety feet on the outcrop of the deposit. The layers of ore and wall rock have been dislocated. The lines *a a* show the position and extent of a fault that has shifted the deposit two feet towards the northwest, and the line *b* represents the angle at which the ore pitches beneath the rock towards the northeast.

Fig. 9.



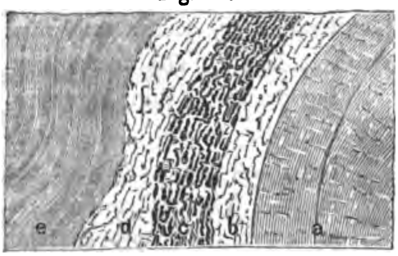
VERTICAL SECTION OF BEACH MINE, OCTOBER, 1855.

This ore was discovered about seventy years ago, and the discovery led to the location of the mine lot and the working of the deposit to the depth of ten or twelve feet. About twenty-five years ago it was worked by Captain William Scott, to the depth of twelve or fifteen feet; and two years ago it came into the possession of Dr. C. Beach, who has worked it to the present time, and removed therefrom three thousand tons of ore, the greater part of which has been manufactured into blooms at the

forges in the vicinity, and the remainder sold as furnace ore. The blooms have been manufactured chiefly into hoop iron.

Beachglenn Mine.—This mine is situated on the northeastern border of Beachglenn pond, about one mile southeast of the Hibernia Mine tract. It was opened about sixty years ago, and worked only a few feet in depth and upon the surface. Four years ago the work was resumed, and carried to a considerable extent, exposing the layers of rock and ore in two different localities, viz: 1st, in what is known as the Southwesterly opening, which is situated on the border of Beachglenn pond, and has been worked three hundred feet on the deposit, and fifty feet in depth. The annexed transverse section (Fig. 10), shows the relative position and character of the layer of rock in which the ore is found; *a* is a hard, compact laminated rock, composed of quartz and feldspar, interspersed sparingly with grains of magnetic iron ore and scales of brown mica, and is transversed by numerous joints at right angles to the planes of lamination; *b* and *d* are schists composed of white feldspar, black hornblende, brown mica, and grains of magnetic iron ore, in about equal proportions, sparingly interspersed with small imperfect crystals of quartz; *c* is the layer that has been removed for its ore. It is a coarse, granular rock, averaging five feet in thickness, and composed of white feldspar, black hornblende, brown mica, and magnetic iron ore; the latter generally predominating over the other constituent minerals; *e* is a hard feldspathic schist, containing hornblende and magnetic iron ore in admixture; the mica entering but sparingly therein. The strata are very much curved and contorted; that which contains the

Fig. 10.



TRANSVERSE SECTION OF BEACHGLENN MINE, SOUTHWESTERN OPENING.

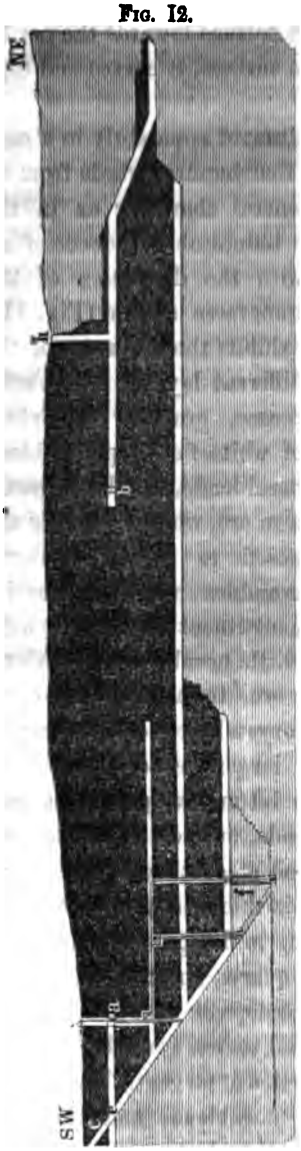
greatest proportion of ore, dips at the surface towards the northwest; but, twenty-five feet below the surface, it curves and dips slightly to the southeast.

2d. The northeastern opening is situated apparently in a continuation of the same deposit, about four hundred yards from it. The ore here possesses the same general character as in the other opening, and affords the same indubitable evidence of an aqueous origin, contemporaneous with the deposition of the rocky strata. The accompanying transverse section (Fig. 11), exhibits the character of the different layers; *a* is a soft, coarse, granular admixture of white feldspar, black hornblende, and magnetic iron ore, which, on being exposed to the atmosphere crumbles and sets free its constituent minerals; *b* is composed of quartz, feldspar, and a little hornblende, interlaminated with bands of magnetic iron ore, from one-half to two inches thick. It possesses a highly crystalline, columnar structure, as distinctly marked as in the larger deposits, of several feet in thickness; *c* is similar to the latter, except that it contains a greater proportion of hornblende, and less magnetic ore; *d* is composed of quartz, feldspar, and magnetic ore in laminæ, varying from half an inch to an inch in thickness; *e* is composed chiefly of quartz and magnetic ore, in irregular masses and nodules; *f* is composed of feldspar, quartz, and magnetic ore in distinct laminæ. The portion of the deposit that has been removed, is represented at *c* and *d*, and varies from five to eight feet in thickness. Its average proportion of magnetic ore is about one-third; of feldspar one-third; of hornblende and mica each one-sixth. Its crumbling is due to the decomposition of the feldspar. The deposit is nearly vertical, dipping, near the sur-

Fig. 11.

TRANSVERSE SECTION OF BEACHGLENN MINE, NORTHEASTERN SECTION.

FIG. 12.



VERTICAL SECTION OF SWEEDS MINE, OCTOBER, 1855.

face, slightly towards the northwest, but, a few feet from the surface, curving towards the southeast. It has been worked to the depth of twenty feet, and three hundred on its line of bearing.

KITCHELL AND MUIR MINES.—Three quarters of a mile southwest of the Beach Mine, on the same ridge, occur the Kitchell and Muir Mines, the general character of the ore and wall rocks of which are similar to those of the Beach Mine. The ore deposit is two feet thick, and dips at an angle of 75 degrees towards the southeast. The Kitchell Mine has been worked to the depth of one hundred and thirty feet, and upwards of two hundred feet on the deposit.

SWEED'S MINE.—Three miles southwest of the Kitchell Mine is the Sweed's Mine. It is situated on the bank of the Morris Canal, one mile east of Dover. The outcrop of the deposit of ore is on the southeastern slope of a hill; the highest point of this outcrop being seventy feet above the level of the water in the canal. There are two adits to this mine, *a* and *b* (Fig. 12), entering the side-hill at a distance of about one hundred yards from the canal, and being at their entrance,

one seven, and the other thirteen feet above it. They cut the deposit thirty, and sixty feet, respectively, below the surface; that at *a*, however, being connected with the plane, is the one used at present in taking out the ore.

The workings at this mine are rather extended than deep, the ore having been removed from the whole length of the deposit, as the workings were extended downwards. The northeastern brest has been driven to a distance of six hundred and eighty feet from the plane, and a gallery has been driven back of the plane, in an opposite direction, for a distance of one hundred and eighty-three feet. There are, at present, but two stopes worked, although a new one is in progress. These worked, are designated as the middle and bottom. The middle stope is seven hundred and thirty feet from the plane, measuring on the gallery leading to it; the bottom stope is two hundred and ten feet from the foot of the plane, measuring in the same way. The deepest working in the mine, which is now the sink, is one hundred and seventy-five feet below the surface. There are two shafts, at present, open at the surface, one of which, the pump, *a*, measures eighty-five feet in depth. This shaft, as will be seen from the measurement, does not reach to the bottom of the mine; and the water is raised at successive lifts from one gallery to another. The other, called the chain way, or grass shaft *h*, is sunk one hundred and eighty-eight feet below the surface.

The thickness of the deposit at the northeast stope is nine feet but is here mixed with seams of rock; at the middle stope, the ore measures thirteen feet, and at the bottom stope, ten. Towards the southwest, it becomes narrower; and in the sink it is but three feet. At different places, along the plane, the thickness measures three and a half, two, and two and a half feet. The thickness in the gallery, at the southwest end, back of the plane, is one, and one and a half feet. The average dip is 57 deg. N. W.

The following are extracts from Mr. Wurtz's report:

"This large mine, important both on account of its convenient proximity to the canal and the very large quantity and valuable quality of ore which has been, and still is, taken out of it, is worked upon an extensive but irregular bed of ore, or rather of a mixture of ore and black hornblende, which has the usual stratum-like form and correspondence with the beds of the surrounding crystalline schists in its N. E. and S. W. strike and steep dip to the S. E. The 'vein,' so called by the miners, is made up of a series of subordinate beds or seams, mostly composed as above stated, of mixtures in variable proportions, of magnetic iron and black hornblende in crystals of considerable size, some seams however being composed of magnetic iron, more or less pure, and some of feldspar or quartz. Neither pyrites nor phosphate of lime were observed to be present in the ore at any time.

"The specimens were collected from three parts of the mine, from the N. E. and S. W. extremities of the present workings, and from a point intermediate between them, called the middle stopes. These three points are at different elevations, the N. E. stopes being nearest the surface of the ground, the S. W. stopes the deepest part of the mine, and the middle stopes intermediate between them. A great portion of the mine lying still farther to the S. W., from which the ore has been wholly or partially worked out, is inaccessible, in consequence of the columns of ore left to support the hanging wall, at the time it was worked, having been removed, and the earth from above allowed to fall in, and fill up the excavation.

"(1.) At the N. E. stopes the hanging wall is a feldspathic schist, containing a little quartz and some laminæ of black hornblende and magnetic iron.

"The ore taken from the central portions of the bed is a coarsely granular mixture of black hornblende and magnetic

iron in variable proportions. An imperfectly developed schistose structure appeared in some places. It has no jointed structure.

"The foot-wall is very similar in appearance to the ore, but has a quite distinct schistose structure, and contains more hornblende, together with considerable feldspar. It seems probable, however, that at this place the true foot-wall had not been reached, and that this was one of the poorer seams of the ore bed, lying in proximity to the foot-wall.

"(2.) At the middle stopes the hanging wall is a mixture of crystals of considerable size of black hornblende, feldspar and magnetic iron, having a doubtful schistose structure.

"The ore is precisely similar to that at the N. E. stopes, with sometimes a few joints. It is also indistinctly schistose in places.

"The foot-wall is an indistinctly schistose, small granular, crystalline, feldspathic rock, with a little quartz and a few minute grains of magnetite interspersed. It contains also some pyrites.

"(3.) At the S. W. stopes, the hanging wall is a mixture of large crystals of flesh-colored feldspar and qnartz, with a few grains of magnetic iron interspersed. It has a schistose structure, sometimes however imperfectly developed.

"The ore is large granular and crystalline; sometimes schistose, some laminæ consisting of altered hornblende; and sometimes very pure, with a jointed structure. It is somewhat stained with limonite.

"The foot-wall is a small granular feldspathic rock, containing intermixed grains of magnetic iron, and sometimes seams of the same mixed with hornblende. It has in most places no visible schistose structure.

"(4.) Specimens were also taken of a 'horse' found in the ore, which is a crystalline feldspathic rock, apparently destitute

of schistose structure, containing, in some places, some diffused brown mica, and in others diffused particles of magnetic iron.

"(5.) The miscellaneous specimens comprise masses of feldspar presenting cleavage surfaces an inch in diameter, which belong to the species orthoclase, according to measurement of the angle between the cleavages; seams of magnetic iron in feldspathic gneiss, showing the junction of the ore and rock; a schist of a peculiar and beautiful appearance, composed of a mixture of brown or black mica with a white altered feldspar, the plates of mica being oblong and arranged in a parallel manner; seams of feldspar composed of large crystals in hornblendic gneiss; incrustations of dog-tooth spar in seams in the ore. There were also several specimens which time has not yet permitted me to examine, such as some crystals apparently of a zeolitic mineral; a blue or violet colored substance in amorphous incrustations, etc. A specimen was also found containing many minute crystals of zircon."

MINING.

Having described the geological occurrence of the principal deposits of iron ore, in this part of the metalliferous belt of the Highlands, a few general remarks on the principles of a proper system of mining, as applied to these and similar metalliferous deposits, are deemed of essential importance, in connection with their development.

On account of the great abundance and accessibility of the ore, that attention has not been paid to a systematic and economic plan of extraction which the nature of the art demands.

The manner in which the iron ore of this district has been hitherto chiefly extracted from its bed is as follows: A deposit of ore having been discovered in the summit of a hill or mountain ridge, operations are commenced at its outcrop, either removing it for a distance on the surface, or sinking into it, until the work becomes too expensive on account of the water

which accumulates, or on account of the deficiency of machinery for raising the ore and removing the water. Even when machinery is erected, it is often imperfectly adapted to the work, and thus renders the expense of the work too great to be continued. There is also but little attention paid to the proper construction of mines, regard being had only to the extraction of the ore at the time, and no provision being made for extensions which may hereafter become necessary. This frequently results, sooner or later, in unprofitable and dangerous workings.

Exploring for Ore.—A gradual increase in the manufacture of iron from its ore, in this country, has of late led to the exploration of the iron region of this State in search of that material. A knowledge of the geographical range of its belts, together with their geological position and character, as delineated in the preceding pages, will serve to guide the explorer in his researches for undiscovered deposits, and also for adopting plans by which they may be worked to the best advantage.

The following facts, having a practical bearing on their discovery and working, have been determined:

1st. Geographically, the deposits of ore occur in a series of parallel belts crossing the Highlands, in a northeasterly and southwesterly direction.

2d. Each belt is composed of a series of deposits having the same general direction and inclination, coinciding with the strike and dip of its accompanying rocks.

3d. As a general rule each deposit is exposed at the surface only to a very limited extent, on account of its pitch beneath the rocks, towards the northeast.

4th. The outcrop of ore generally occurs on, or near, the summit of a hill or mountain ridge.

5th. The deposits are traversed by numerous joints and faults, frequently displacing portions of them to a considerable distance.

From these facts it will be observed that the explorer would

be more likely to succeed in his researches for ore, if he should come within the range of a metalliferous belt, although this is not to be considered as an established rule, for deposits sometimes occur at a considerable distance from the conceded limits of a belt. Examinations should be made on, or near, the summit of hills and ridges, also at their base; the former would lead to the discovery of the outcrop, while the character of a loose piece of rock, and sometimes ore, found along the base of the ridge, would indicate that it had been detached from its bed on the summit, or side, and rolled down its slope. As in many cases the wall rocks of a deposit of ore possess the same general character for a considerable distance, a knowledge of them will assist in locating a deposit which may be capped with rock.

On account of the highly magnetic property of the ore, the magnetic needle, or surveyor's compass, is an instrument very generally used in exploring for it; and although it indicates the presence of magnetic iron ore, yet it cannot be relied on as to the quantity and extent of the deposit. This is due to the almost universal occurrence of magnetic iron ore either in grains, seams, bands, etc., as a constituent of the gneissoid and granitic rocks of this region.

A great variety of needles, or compasses, has been manufactured as best adapted to this purpose, depending chiefly on the manner in which the needle is mounted. It is, however, conceded by those who are experienced in the use of these instruments, that the common pocket box compass is as well adapted and reliable as the more complicated and costly instruments made expressly for this purpose.

The ordinary way of using the pocket compass in exploring for ore, is as follows: the explorer, holding it in his hand, near the ground, taking care to keep it level that the needle may swing freely, crosses the locality under examination in a northwesterly or southeasterly direction, at right angles to the general direction of the deposit, at the same time closely watching the

movements of the needle. If magnetic iron ore be present, the magnetic pole of the deposit (the deposits generally possessing magnetic polarity) which is nearest, will begin to attract the opposite pole of the needle, and this attraction will continue to grow stronger until a position is reached directly over it. The needle will then settle firmly in the direction of the longer axis of the ore deposit, and if the attraction be strong it will not move from that position even though the compass be shaken. Sometimes, as the ore lies in parallel beds, two or three successive attractions will be observed, the needle at each time behaving in a similar manner. A very good illustration of the attraction and repulsion of different poles of the magnet may sometimes be obtained by walking upon, and in the direction of the ore deposit. When a certain point is reached, the needle will be reversed. There are two places on the deposit at the Richard Mine where this is exhibited.

The indications of the compass are often very deceptive; for the needle may stand very firmly where there is but a small mass of ore, if it be near the surface; and, on the other hand, if it be some distance below the surface, the needle may give but a very faint indication, when in reality there is a large body of ore.

Having located a deposit of ore, its probable extent and quality should be determined before making arrangements for working it on a large scale. This is necessary on account of the frequent occurrence of bands, bunches, and seams of ore, which do not expand to any considerable size. The manner of determining its probable quantity depends on the nature of the locality, extent of the outcrop, etc. This is generally done by sinking small test or trial shafts, cross-cuts, borings, etc. Having determined by these examinations that the extent of the deposit and quality of the ore are of a character to warrant the opening of the mine, and extending the workings to an indefinite extent, a survey of the premises, showing the irregularities of the surface, the position

of the deposit both as regards its strike, dip, etc., should be made and plotted on paper, before a hammer or pick is used. Such a survey will enable the experienced mining engineer to determine the most feasible plan for conducting his operations, a matter of the greatest importance in working iron mines in this region, where the value of ore, in proportion to its bulk, is very small.

Open Workings.—The simplest method of mining is by what are called "open workings;" but this is only applicable where the mineral is in large quantity and near the surface. The plan usually followed in this case is first to strip off all the earth, or other superincumbent material, and then to conduct the workings in regular terraces, so as to facilitate the removal of the ore and rubbish with the least possible expense. The crumbling or washing down of the sides must be guarded against, by giving them a proper slope or by props of timber; and ditches, or water drains and surface drains, must be dug, in order to keep the workings dry, as far as possible, in wet and stormy weather, and during the winter season. The mine that has been worked most extensively on this principle is that at Andover, Sussex Co.

Underground Workings.—The other method, and that which in most cases has to be resorted to, is by underground or subterraneous workings. These are commenced and continued, either by shafts, or levels, or both, as the nature of the ground and the position of the deposit may demand.

In all cases where the configuration of the surface, and the situation of the mineral deposit will allow, an "adit-level" should be driven either in the deposit or from the lowest ground adjoining. When the deposit crosses the general direction of the ridge, or hill, in which it is situated, the adit should be driven into it upon its course. The Wood Mine at Hibernia, is a good illustration of this kind of adit. But when the deposit runs along the side of a ridge or hill, parallel to its course, the adit must be cut through the adjacent rocks, which is frequently

a very expensive undertaking. In the case of a "shaft," which is the other alternative, the cost of machinery, of pumps, repairs and attendance, are to be considered. When the nature of the surface will not allow an adit-level, a shaft must be sunk, its location being determined from the position of the deposit, its dip, etc. When a deposit of ore has been removed above the adit-level, the working is continued by means of shafts, through which the ore may be raised, and the water pumped to the level.

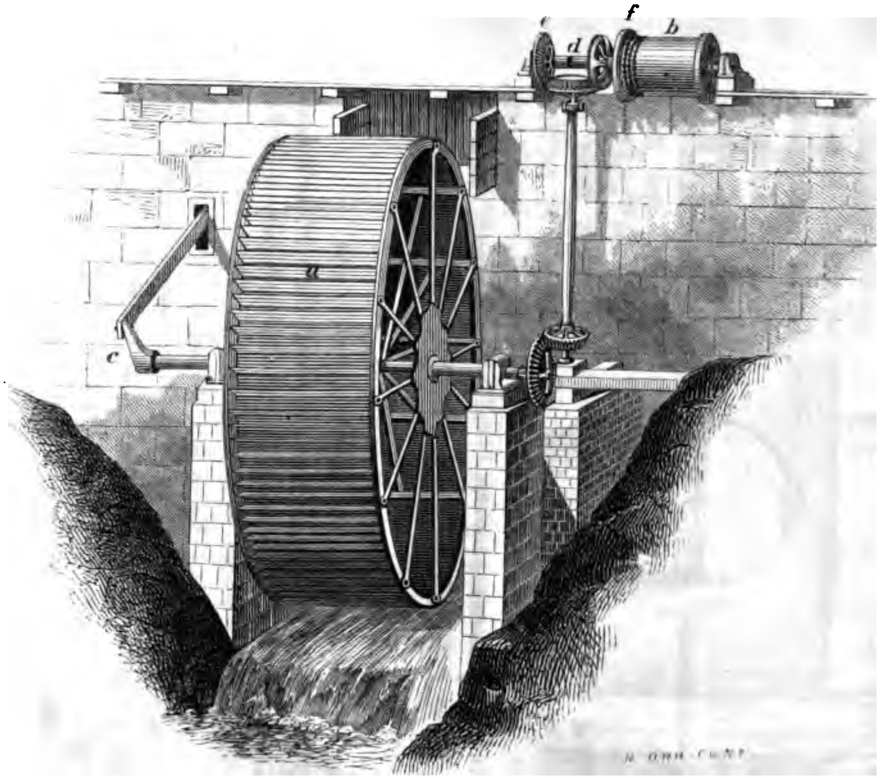
TIMBERING.—In all shafts or levels which are sunk or driven through earth or loose rock, the practice of "timbering" must be resorted to, in order to prevent these substances from falling into, and filling up the excavation. The wood most generally used for this purpose, in the New Jersey iron mines, is chestnut; though locust, white oak, red oak, red pine, or any other durable wood, will answer the purpose. It should be flattened on two sides, stripped of the bark and seasoned, before it is put into the mine. Its size should not, as a general rule, exceed ten inches in thickness, on account of inconvenience in handling, as machinery or pulleys cannot well be used in a mine, and the sticks must consequently be set by hand.

The timbering of a shaft is usually rectangular in form; and in most mines requires only to be carried through the loose earth and disintegrated portions of the rock above, or until solid rock is reached, which is usually not over thirty feet; here it rests on a bed cut in the rock, sufficiently solid to prevent its displacement. The timbering in an adit is different from that in a shaft, being somewhat smaller at the top than at the bottom on account of inclining side posts, in order to resist the pressure. It should usually be six or seven feet high, five or six feet wide at the bottom, and three at the top. The timbering in the galleries and other parts of the mine consists merely of heavy timbers extending from wall to wall, one end being set into a step cut into the foot-wall to receive, and the other bearing against the hanging wall. If the wall be slaty or unsound, the timber may bear

against a wall-plate of plank, in order that it may give support to a large surface.

EXTRACTION OF ORE.—After the shafts have been sunk and galleries run horizontally from them, the work of extracting ore begins. This is done by what is called "stoping," or working in steps. There are two methods of doing this, one called overhand, and the other underhand stoping. The difference between them is, that in the former the ore is removed from below upwards; while in the other method it is removed from above downwards. The latter method is usually adopted in this region, and is considered the most economical. A good illustration is given in the section of Sweed's Mine, (Fig. 12, page 230), showing three stopes. The lean ore and rubbish is piled upon the timbers put in to support the walls, thus forming what are termed "stulls." In these piles of rubbish, openings called "mills, passes or shoots," are left, through which the ore may be thrown down into a car on the level or gallery below. The rubbish piled upon the timbers forms an additional support to the walls in those parts from which the ore has been removed. It is a great fault in most of these iron mines that too much stoping surface is exposed. The reason of this is, that the deposits, in most instances, are so wide and so pure that they are removed without leaving any rubbish to support the walls. The mines are thus so open as to be very dangerous for the workmen. When there is not enough rubbish furnished by the mine it may be obtained, when the underhand method is pursued, by cutting away the timbers and letting down that from above; and when enough is not furnished by this expedient, it may be thrown down from the surface. This method is advantageously pursued at Sweed's Mine.

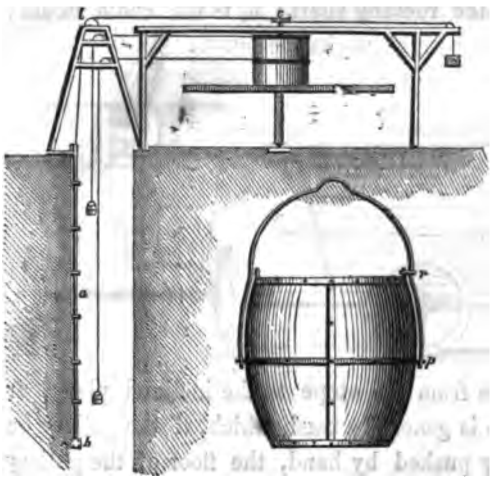
HAULING AND HOISTING.—In beginning to sink a shaft, for the first fifty or sixty feet, the ore, rock and rubbish, may be raised by means of a common windlass, such as that used in wells. When the shaft does not exceed one hundred and fifty



MACHINERY. SWEEDS MINE

feet in depth, the work may be done economically by a horse; and the machine used for this purpose is called a horse-whim, a good form of which is represented in Fig. 13. Sometimes an arrangement for pumping is connected with it, as seen in the same figure. The horse, by turnthe sweep *f*, winds the chain upon the drum, and thus raises the "kibble," which is made to descend by reversing the motion of the sweep. If, however, the shaft exceeds one hundred and fifty feet in depth, water or steam power may be more advantageously employed, though either of these may be economically used at the very beginning, provided operations are carried on to a great extent.

Fig. 13.



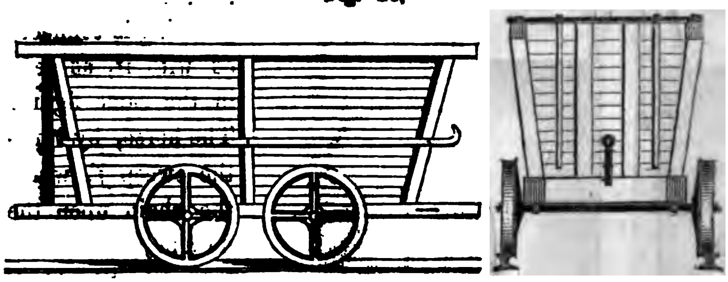
HORSE-WHIM AND KIBBLE.

In Sweed's and Mount Pleasant mines, the hoisting is done by water power. The arrangement of the machinery used for this purpose at Sweed's Mine, is shown in Fig. 14; *a* is the water wheel, connected by means of mitre gearing with the chain drum. The motion is reversed by means of the sliding clutch *d*, which connects the drum with either of the mitre wheels *e* or *f*, as a forward or backward motion is required. The motive power, by this arrangement, may be always in one direction, as is necessarily the case when water is used.

In the use of steam power various kinds of engines are employed. Those at the Glendon and Byram mines, (see Fig. 15) are very convenient in form for small workings, being simple in their con-

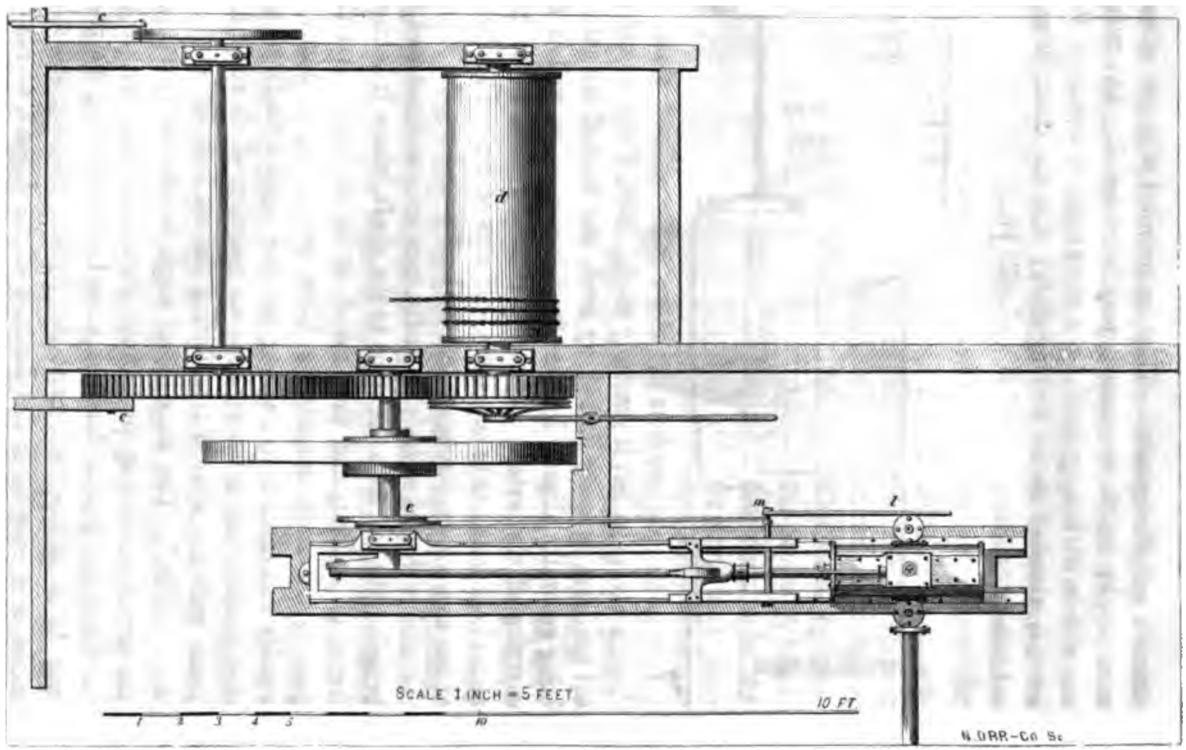
struction and arrangement. They are provided with two eccentrics, e e, by which the motion may be reversed. The valve may also be worked by hand, for a short time, by means of the lever, *l*, attached to the rocking shaft; *d*, is the chain drum; and *c* the connecting rod which works the pump.

Fig. 16.



In removing the ore from the stope to the inclined plane, or shaft, a car, (Fig. 16) is generally used, which, if the gallery be not too long, is easily pushed by hand, the floor of the gallery being generally slightly inclined for this purpose, as well as for carrying off the water. The cars generally used at the iron mines hold from one to one and a half tons of ore. They have, at one end, a door, through which the load is discharged. Where the mine is worked entirely by shafts, cars are sometimes used for bringing the ore from the stope to the shaft, where it is transferred to buckets, and then raised to the surface. But this plan causes much unnecessary labor, as the object might be equally well effected by running the cars upon a platform, and then raising them to the surface—an operation which would dispense with the labor of transferring the ore from the cars into the "kibble." The same object might be effected by running the cars themselves up an inclined plane to the surface. When the dip of the deposit does not exceed 40 or 50 deg., the plane may be on its foot wall, as at the Byram, Sterling and other mines, or it may be in the direction of the deposit, as seen in the section of the Sweed's Mine, the arrangements for the work-

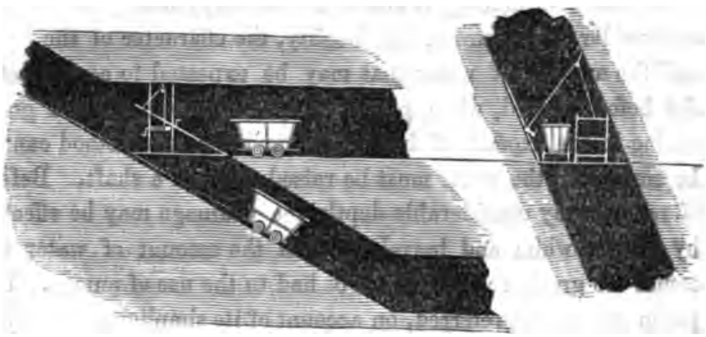
Fig. 15.



Engine, with Machinery for Hoisting and Pumping, Byram Mine.

ing of which are, perhaps as economical as any adopted throughout the Highlands. There are two adits to this mine, perpendicular to the direction of the deposit, and entering the hill at *a* and *b*. The ore here is loaded into the cars at the stopes, and then pushed by hand to the plane *c*, where a chain is attached to them, by which they are raised as far as the gallery *e*. Then they are drawn by a mule through the adit *a*, to the canal bank, and emptied directly into the boat.

Fig. 17.



A very ingenious arrangement, used for connecting the galleries with the plane, is shown at Fig. 17. When the car is to pass to the lower gallery, the track of the upper gallery is raised by the windlass and block, and the car passes under; but if it is to go on the upper gallery, the track is let down into its places and the car runs into it.

The pumping arrangement at this mine is also very simple and convenient. The water is raised at three successive lifts, from one gallery to another, and discharged at the adit *a*, (see Fig. 12, page 230,) whence it runs into the canal. At the mouth of the adit, there is a trough arranged for washing ore with the water from the mine. The pumps used are of the common "lifting" kind, and are nine inches in diameter.

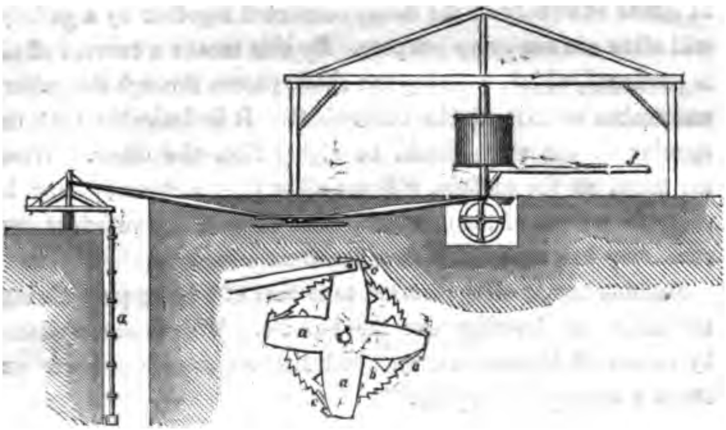
In the section is shown the manner in which a new stope is begun. The shaft *f*, is first sunk to a depth equal to the required height of the stope, a pump being carried down with it to prevent the water from interfering with the workmen. The angle is then worked off in the manner indicated by the dotted line; and a new stope is thus formed, and a new gallery begun. A similar method of beginning a stope is shown in the section of the Byram Mine.

Drainage.—As this is one of the most expensive operations connected with mining, it becomes necessary, in adopting a plan, to consider the nature of the locality, the character of the rock, and the amount of water that may be expected to accumulate. As before stated, when practicable, an adit will effect a great saving in the expense of draining; but when this method cannot be employed, the water must be raised through a shaft. Before it reaches any considerable depth the drainage may be effected by a horse-whim and barrel. When the amount of water becomes too great, recourse must be had to the use of pumps. The pump generally preferred, on account of its simplicity, facility of repair, etc., is the "lifting pump," or combination of the "sucking" and "lifting pump," inasmuch as it raises the water by "suction" for the first twenty-five feet, and lifts it through the remaining distance. This pump is not easily deranged, and if it should become so, is readily repaired when under water.

Pumping, as well as hoisting, may, in the beginning, be effected by horse power, the pump being connected with the whim, as shown in Fig. 13, page 241. *a* is the pump, worked by a chain which, passing over the pulley, is connected to the crank at *c*. The weight *w* is a counterpoise for the purpose of moderating the force of the "back-lash," caused by the weight of the pump-rod and the column of water raised at each stroke. Another arrangement, in use at the Richards Mine, by which the back-lash

is avoided, is shown in Fig. 18, the connection for working the

Fig. 18.



pump being below instead of above, as in the preceding figure. In this arrangement the connecting-rod is attached to a pair of iron cross-arms *a a*, which, in one direction, may revolve independent of the ratchet-wheel, with which they are connected in the other direction by the spring-catches *c c c*. When the rod begins the downward movement, its weight, with that of the water above the bucket, causes it to descend with great force, and thus the arms are made to revolve with greater rapidity than the ratchet, though in the same direction. When the rod has fallen as far as its weight will carry it, the arms are again taken hold of by the ratchet, and carried forward as before. In this way, by the falling forward of the rod, nearly a quarter of a revolution is gained each time. By using a pump connected in this manner with the hoisting arrangements, the mine is freed from water at the same time that the ore is hoisted. The engine best adapted to pumping is the modification of the Boulton and Watt engine, now generally known as the Cornish engine.

Ventilation.—The air of mines becoming vitiated by the breathing of the miners, the burning of candles and lamps, and

the explosion of gunpowder, recourse must be had to some means for purifying it. This may be effected in various ways. A shaft at either extremity of the mine, connected together by a gallery, will often answer every purpose. By this means a current of air is produced, which, entering one shaft, passes through the gallery and makes its exit at the other shaft. It is desirable that the opening of one shaft should be higher than the other. When the mine, at the surface, will not allow this, a chimney may be erected over one of them, which, when there is not sufficient current, may be connected with a flue from a furnace.

Another means often resorted to is that of forcing pure air into the mine, or drawing out the bad air. This is accomplished by means of blowers, among which the common fan-blower answers a very good purpose.

CONCLUSION.

As soon as the explorations shall have been completed over the whole of the metalliferous belt of the Highlands, generalizations will be made, that will show in a condensed and tabular form:

1st. The different varieties and character of its ores.

2d. Their chemical composition, and their relative economic value.

3d. Their geological position, and their geographical distribution.

4th. Their natural advantages for being extracted.

5th. The manner in which they should be mixed; the fluxes and fuel that should be used, as best adapted to the manufacturing of different kinds of iron.

6th. The most favorable locations for the erection of iron works, combining the greatest advantages as derived from the above considerations.

Enough, however, has been said in the detailed descriptions of the principal mines, as contained in the preceding pages of this report, to show that this district is pre-eminently an iron-ore-

bearing district, unrivalled by any like extent of territory in the Union. With very great propriety, indeed, did an eminent statesman recently propose that New Jersey be called "*The Iron State;*" for it may be said, with entire truth, that the mountain deposits of iron-ore, above water-level, in its Highlands, are sufficient to supply the demand for iron in the United States for many years to come.

The following considerations determine the most advantageous location for the manufacturing of iron:

1st. Quality, quantity, and accessibility of the ore.

2d. Cost and nature of the fuel to be employed.

3d. Cost and accessibility of the proper fluxes.

4th. Cost of labor, machinery, etc.

5th. Proximity to market.

Does not this district, possessing the richest of ores, in its mountain deposits, of magnetic, specular, hematite, franklinite, and bog ores, the best of fluxes in its great variety of limestones, its accessibility to the anthracite coal-fields of Pennsylvania, its proximity to New York and Philadelphia, the great iron depots of the country, combine all these advantages in a remarkable degree? There is no reason, then, why New Jersey shoud not become, *par excellence*, the greatest iron-producing State in the Union. Statistics show that the annual consumption of iron in the United States, during the past few years, is not far from 1,500,000 tons, of which only about 800,000 tons have been produced here. This consumption is annually increasing by the use of iron in the construction of railroads, iron buildings, vessels, pavements, etc.; and do not these facts demonstrate that the manufacturing of iron must be increased in this country? But where will these manufactories be located? Undoubtedly where the purest and most accessible ore is found in proximity to an abundance of fuel and fluxes, as well as to a proper market.

The increasing intelligence and enterprise of the citizens of this State, are rapidly leading to the development of the natural